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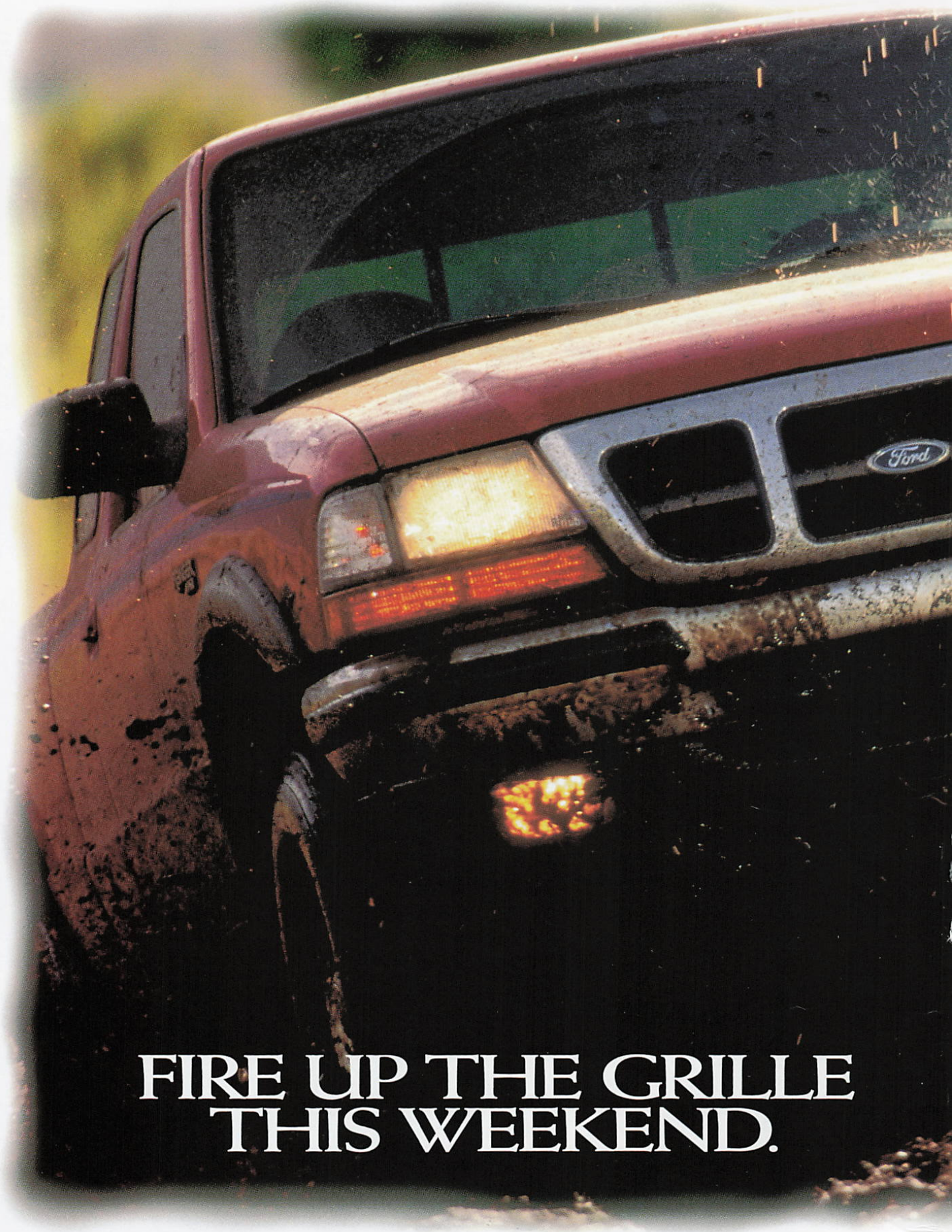

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FEBRUARY 1998
VOLUME 175
NO. 2

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PM cover photo by Cliff Gromer

EDITOR'S NOTES

● Bob Lutz is not your average Chrysler Corp. vice chairman. You just don't picture vice chairmen of major corporations blasting around freeways in souped up Dodge Vipers, ripping around on Kawasaki Ninja cafe racers or flying their own helicopters. These are just some of the normal pursuits for Lutz. So I wasn't that startled when he broke the news to me. We had seen each other across the floor of the Detroit auto show. It was the Friday night black-tie charity event that kicks off the show each year. Through a forest of dazzling women in little black dresses and men in tuxedos, I spotted Lutz and his beautiful bride, Denise, in the middle of the Chrysler exhibit, and he spotted me. He waved me over. "Joe, I just bought something that I'm really excited about." For a moment, I wondered what else Bob Lutz could buy that would excite him. He already owned a garage full of cars, helicopters, motorcycles and other boy toys. What could it be? "A jet fighter plane," he said, beaming like a little kid with his first 426 Hemi Cuda as he told me all about his Czech Republic L39 Albatros. Then and there, I received an education on combat jet fighters that you can purchase from any number of foreign nations. "Joe, you've got to come up with me after I clean it up. It's a 2-seater," Lutz said. Well gee, thanks, Bob. But being the original aviation scaredy-cat, I'll pass on that one. But Contributing Editor Cliff Gromer will go up with you as part of the research for this month's cover story, which begins on page 58.... **Don't think of them as computers.** Think of them as extensions of your TV set. That's the hope of companies making the set-top boxes you've seen advertised under the names WebTV and NetComputer. These boxes actually are computers, of course, but their main purpose is to allow you to get online with a minimum of hassle and/or knowledge of computers. And they work very well, as Contributor Rebecca Day relates in the article beginning on page 55.... **It's February.** Time to think boats. This year, the big news is not actually in the boats themselves but what's powering them. Lots of new engines and lots more horsepower are there for the asking—at a price, of course. The whole nautical story unfolds for you beginning on page 79.... **Lastly, we encourage you** to visit the Automotive Hall of Fame, in Dearborn, the next time you're in the Detroit area. Take it from me, it's a terrific place to play hooky some afternoon. I can attest to that personally. On page 77, you'll find a moneysaving coupon, good all year, that will make your visit even more enjoyable. See ya there. Till next time.

PM PHOTO BY RITA McCAY

Gromer, Lutz and the L39 Albatros.

Joe Oldham

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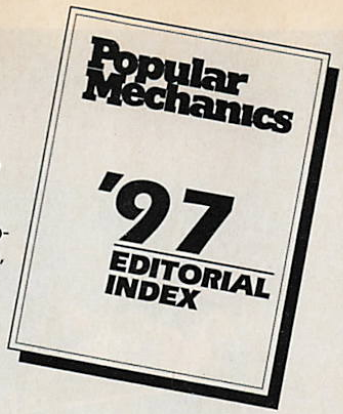

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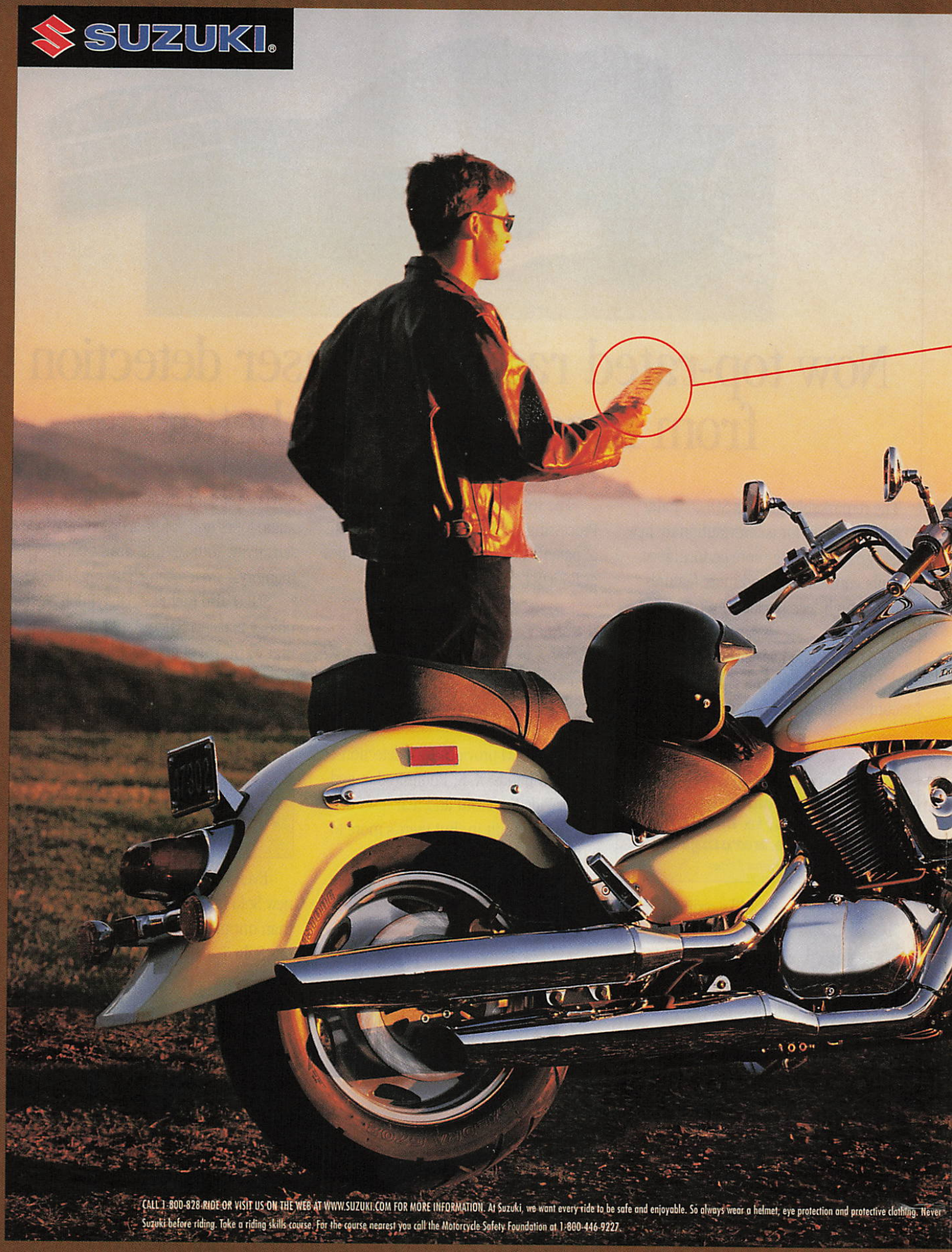
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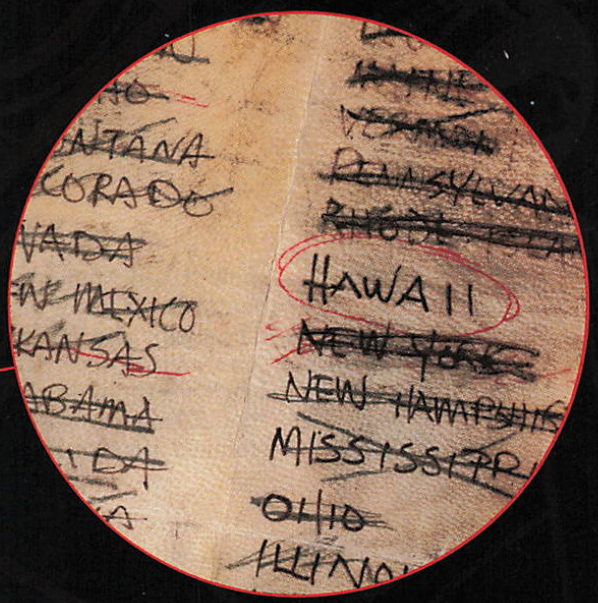

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LETTERS

O.J. Overload

The appearance of that disgusting, digitally manipulated photo of O.J. Simpson should never have been published. You turned this reader's stomach.

JERRY MAYWALD
DEBARY, FL

Did you have to run that photo to illustrate your article? You could have run a less controversial photo that

was digitally manipulated, like the one that shows Lee Harvey Oswald singing, with Jack Ruby on guitar and the sheriff on keyboards.

CHARLES SMITH
VIA INTERNET

I don't care if you run advertisements for guns or show naked women driving boats. But I draw the line when you run Mr. Simpson's picture *several* times. I believe the only thing he should have on his feet are stainless steel leg-irons.

ED PINSON
BOISE, ID

I went into shock when I saw the article with that grinning, idiotic creep O.J. Simpson. I might just tear the article out and forward it to you so I don't get upset every time I look through that issue.

EDWARD PERRY
VIA INTERNET

Those combat boots you put on O.J.'s feet would have done more good had you stuck them up some other part of his body.

BILL WIGGINS
JAMAICA, NY

Letters are subject to editing for length, style and format.

Apple Versus PC

I was disappointed by a glaringly obvious omission in your report about laptops with larger screens. Nowhere did you mention Apple Computer's Powerbooks. I realize that the press has an immense anti-Apple bias. I had hoped that your magazine was not the same.

BRIAN J. KOSKI
VIA INTERNET

You hardly ever mention Macintosh products in your magazine. Wall Street may have problems with Apple, but for those of us who use computers every day, Apple Computer is a leader in technology, reliability and user-friendliness.

SCOTT SMITH
EXPORT, PA

We use Macs here at PM to produce the magazine each month. —Ed.

A Little Help From Your Friends

I just loaded my new PM *Automotive Repair Manual* on CD-ROM and, right off the bat, I learned there are two recall notices for repairs that I already paid for. I've written the car manufacturer and expect the reimbursement to be nearly 10 times the cost of the CD.

ROB SACLO
VIA INTERNET

Tech Time Warp

Your article on fax machines reminded me of when I serviced them in the early '60s. Back then, transmitters and receivers were about 20 pounds and 2 ft. square. We couldn't use regular phone lines. We needed a special direct line. Sometimes a regulated power supply the size of a footlocker was required to transmit to different power grids.

DAVID L. RITTINGER
BOIS BLANC ISLAND, MI

Highway Blues

I made a trip with my wife from northeast Minnesota to Montana and Washington. We found the highways in the same lousy shape they were in last year. Plus we're being charged fees for what our taxes used to pay for. Meanwhile, your magazine printed a story that reported the United States financed a $94 billion venture with the Russians into space. Our government is incredibly stupid.

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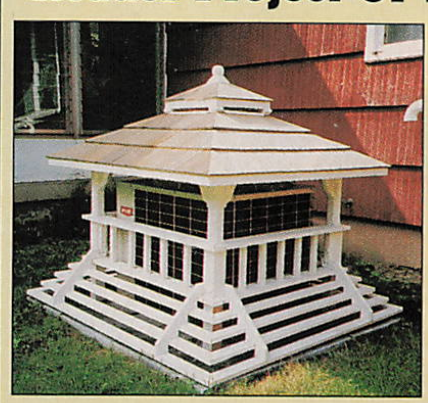

I designed this gazebo to protect a refrigeration unit that is vulnerable to ice damage. Rather than construct a simple tabletop structure, I felt that this design would be more attractive and a challenge to build. The roof, cupola and house side steps and railing are removable to facilitate servicing the unit. I tried to keep the design as simple as possible. The roof and cupola are cut from one sheet of ½-in. outdoor plywood. The shingles are striated cedar, and the rest of the structure is made of pine. Almost all of it is fastened with No. 6 flat head screws. Biscuit splines hold the spindles in place and keep the ends of the stair treads aligned.

VERNON KESSLER
FAYETTEVILLE, NY

If your project is chosen as Reader Project Of The Month, you will receive a Stanley Home Improvement Kit, complete with hand and decorating tools, and an electric stapler/nailer, valued at more than $200. For your project to be considered, please send a clear, color photo and brief description to: Reader Project Of The Month, Popular Mechanics, 224 W. 57th St., New York, NY 10019.

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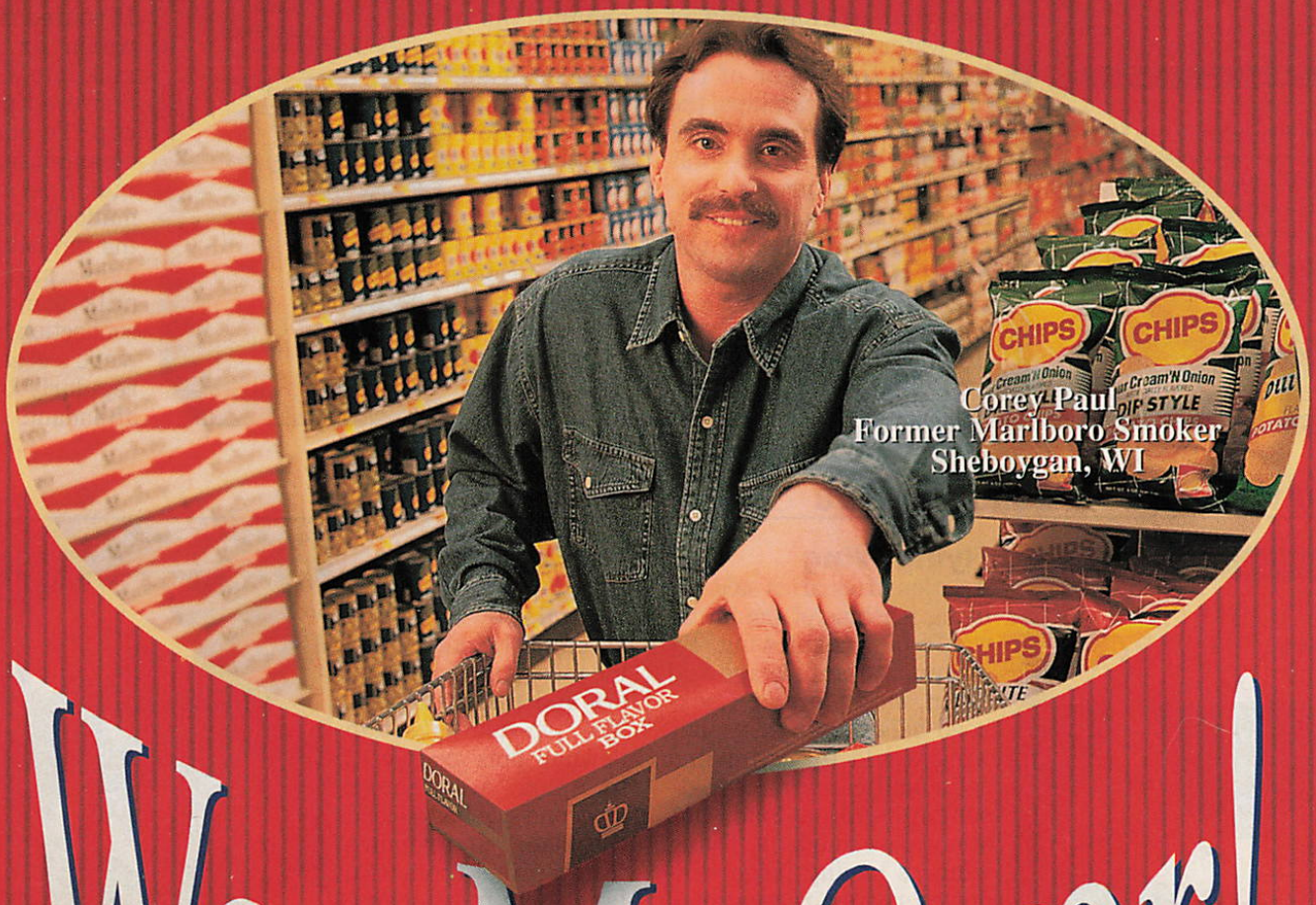

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Target Practice

Our cover showed the British navy blasting one of its own battleships out of the water. In an exercise to test the firepower of the fleet's newest warships, the *Hero*—a worn-out war machine built in 1889—was painted with targets, outfitted with a dummy crew and pummeled by the blasts of 12-in. guns. After the drill, the sacrificial *Hero,* which was once the pride of the fleet, was little more than a twisted mass of iron and steel.

Got Milk?

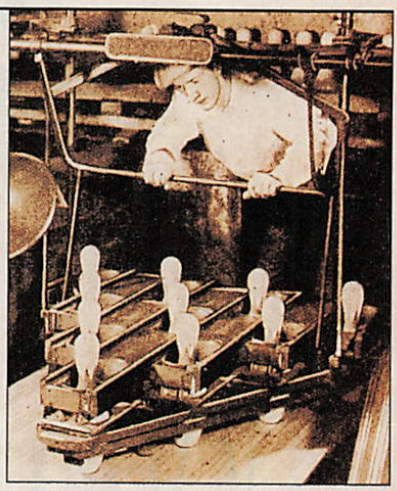
Long before Coke machines popped up around the planet, milk dealers in Germany came up with a coin-operated device that gave schoolchildren milk on demand. And though it looks better suited for giving out fortunes than milk, the mechanism functioned like modern coffee and hot chocolate machines: It poured either warm or cold milk into a predelivered paper cup. To ensure cleanliness, the machine automatically rinsed the tap between uses, and the milk tank and connection hoses were cleaned regularly by an attendant.

60 YEARS AGO: FEBRUARY 1938

Flying Wing

Aviation visionaries said the flying machine of the future would be a giant wing. By scrapping the fuselage and cabin, engineers at Lockheed believed an enormous wing would fly faster and safer and carry more passengers and payload. Our story described the flying wing as having large windowed rooms, recreational facilities and an observation deck. Flying wings never made it into commercial aviation, but they paved the way for B-2 stealth bombers.

No Excuses



Another job lost to automation, bowling alley attendants made way for mechanical pin placers and ball returners. The "pin-spotter" set up bowling pins exactly 12 in. apart. And though someone still had to load the placer and remove fallen pins from the lane, bowling became more of an exact competition. The device also gave bowlers one less excuse for low scores: Missed strikes and spares could no longer be blamed on attendants' sloppy work.

30 YEARS AGO: FEBRUARY 1968

Skidproof Cars

POPULAR MECHANICS got the story behind the secret development of new antiskid systems for cars, which braking engineers across the country were competing to produce. The devices, which became the forerunners of today's antilock brake systems, prevented drivers from losing control on wet or icy roads. If sensors determined that the wheels were skidding, the system would continuously apply and release the brakes until the driver regained control.

Smell Print

No two people smell alike. So when scientists invented a machine to record human odor patterns, our editor signed up to get his own "smell print." Olfactronics, as it was formerly called, measured the relative amounts of odor-producing chemicals—which are unique in every person—given off by the body. The technology gave birth to large ambitions: Engineers envisioned supersensitive sniffers that would one day identify criminals, detect bombs and diagnose diseases by identifying body vapors that cannot be disguised. **PM**

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The all-new Mazda B-Series Trucks.

The B4000 4x4 SE Cab Plus (shown†) comes with: • 4.0L V6 engine • 4-wheel ABS • Power rack-and-pinion steering • Vacuum-operated hub-lock system • Alloy wheels with P265/75R15 white-letter tires • Towing Package • Fog lights • Dual air bags with passenger's-side cutoff switch • AM/FM/cassette stereo with CD • Cruise control • A/C and more

**When properly equipped. †Equipped with the optional Comfort Plus Package and graphics delete option.*

©1997 Mazda North American Operations

For those of you whose sense of adventure isn't bound by convention or commuter lanes, we present our newest family of powerful Mazda Trucks. Built longer, wider, and stronger, they'll tow close to three tons* without ever breaking a sweat. And, with all the rugged performance of the new double-wishbone front suspension and available shift-on-the-fly four-wheel drive, these redesigned Mazda Trucks are bold enough to run over what they don't run through. Then again, anything less wouldn't be worth owning.

Visit us at www.mazdausa.com or call 1–800–639–1000 for all the details.

mazda

Popular Mechanics
FEBRUARY 1998

TECH UPDATE

News Of Tomorrow's Technology Today

GUY SPANGENBERG PHOTO

Look, ma! No hands! This test vehicle steers by looking for magnets buried in the roadway.

A Real Smart Road

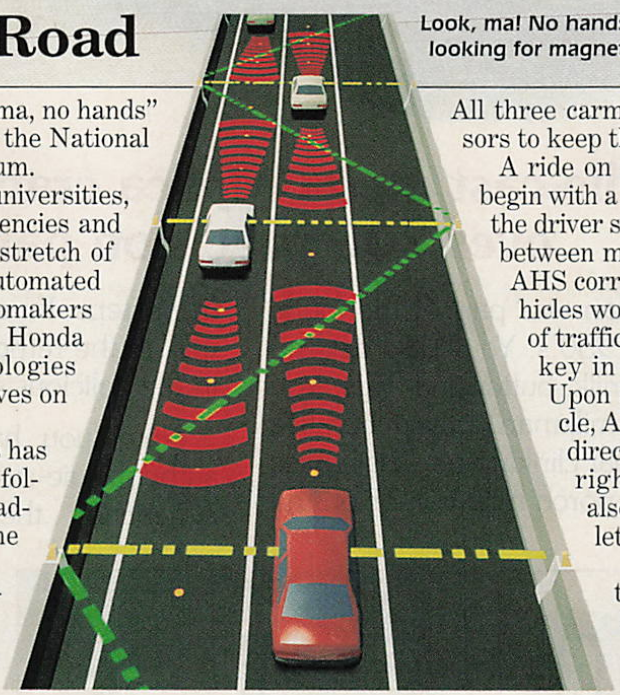
NEW YORK—We could have a "look ma, no hands" network of roads within 20 years, says the National Automated Highway System Consortium.

The consortium, which consists of universities, electronics companies, government agencies and automakers, has converted a 7.6-mile stretch of Interstate 15 near San Diego into an automated highway system (AHS). The three automakers that are part of the consortium—GM, Honda and Toyota—are working on technologies that enable their cars to drive themselves on this stretch of road.

To do this, a fleet of Buick LeSabres has been equipped with magnetometers to follow the magnets embedded in the roadway at 4-ft. intervals, thus guiding the vehicle like a slot car.

Toyota has Avalons that use a forward-looking CCD-camera imaging sensor above the rearview mirror. The device reads and follows the white lines in the road, so no magnets and no changes to the existing infrastructure are necessary.

Honda has a pack of Accords equipped with both systems, so the cars will work in rural situations and on magnet-equipped freeways.



All three carmakers use laser range sensors to keep the cars from colliding.

A ride on an automated highway will begin with a system compliance check as the driver steers along a transition area between manual driving lanes and the AHS corridor. Properly operating vehicles would be injected into the flow of traffic. Once there, a driver might key in a desired cruising speed. Upon approaching a slower vehicle, AHS would pass on the left or direct the slower vehicle into the right lane. The driver might also key in a desired exit and let AHS do the rest.

Conversion to AHS will take several decades, with high-occupancy vehicle lanes the first to benefit from the change.

Editor/Writer: Jim Wilson
Reporters: Louis Brill, Stefano Coledan, Brad Dunn, Mike Fillon, Ken Juran, Mike Lamm, Scott Oldham, Bill Spence, Bridget Mintz Testa, Andy Turnbull

Highlights This Month

- **Blastoff**—*Highest thrill ride gives zero-g experience.*
- **Extinction Alert**—*Biologists race to save the redhorse.*
- **Cyber-Cadaver**—*Virtual body trains future surgeons.*
- **Cleaner Cleaning**—*CO_2 replaces dry-cleaners' solvents.*
- **Astronaut Art**—*Painting with a touch of moon dust.*
- **Vintage Tech**—*Historians recreate a forgotten computer.*

THE 1950 *Borden's* MILK TRUCK

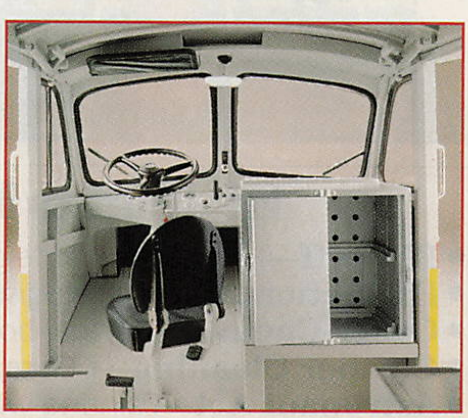
Shown approximately actual size (Scale 1:24; 7½" in length).

A die-cast metal replica crafted from over 200 precision parts.

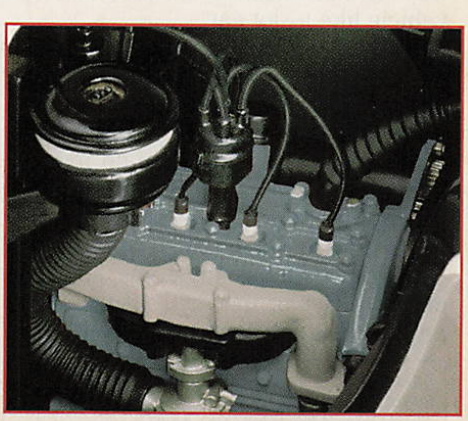
The friendly local milkman was part of the fabric of American life in the 1950's. You could depend on him for the freshest milk, butter and eggs. You always knew when the milkman arrived because you would hear the familiar clinking of glass bottles being stored in the back porch milk box or on the front steps. If you were the lucky one who put the milk in the refrigerator, you could stick your finger in the delicious sweet cream at the top!

Now, you have the opportunity to own an authentic die-cast metal replica of a classic piece of Americana...the *1950 Borden's Milk Truck*.

The back doors open for easy access to the miniature milk crates.



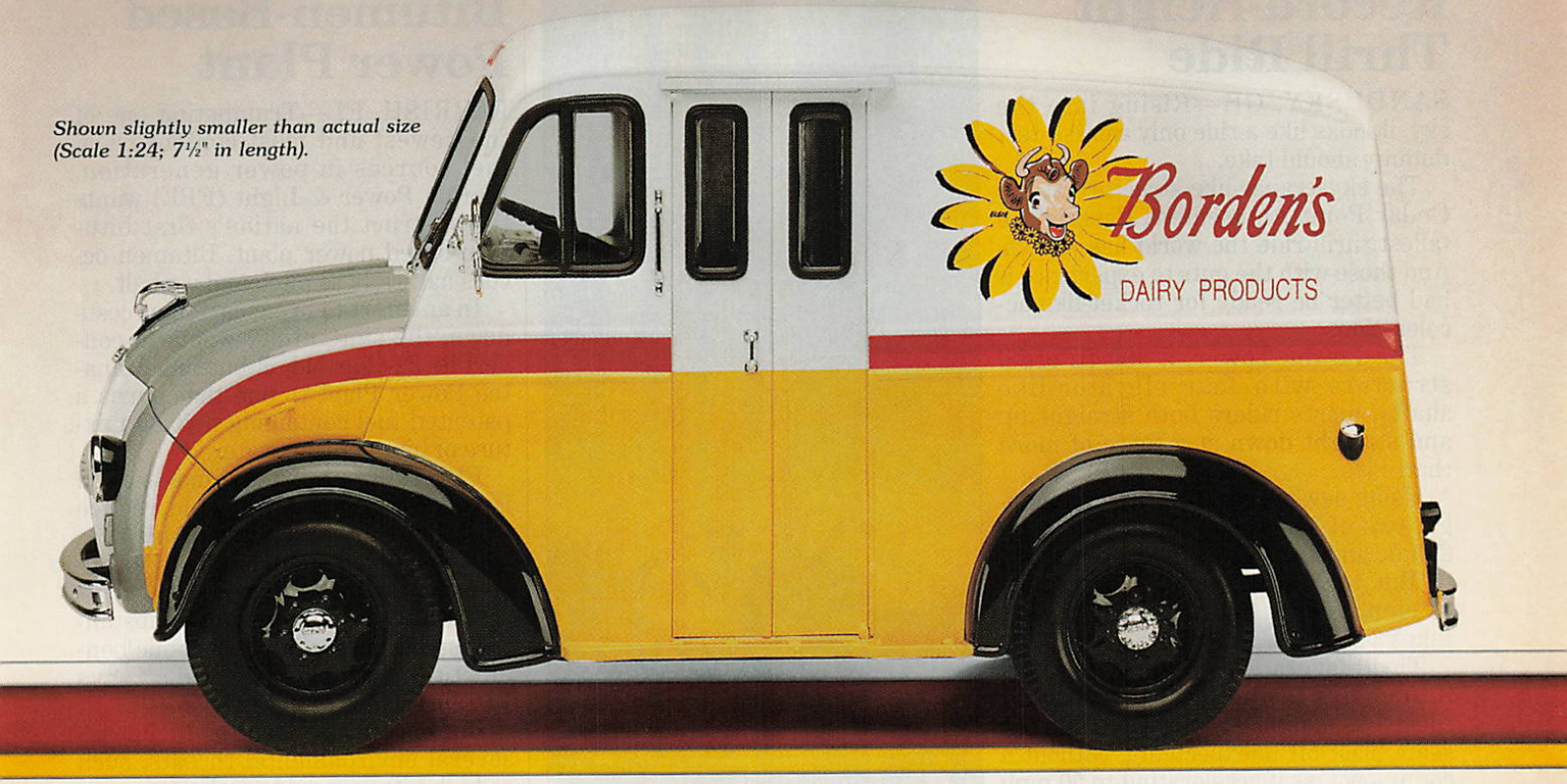
Note the exceptionally detailed interior with authentic dash gauges and fold-down, swing-aside driver's seat.



Open the hood and examine the precise reproduction of the truck's 4-cylinder engine.

Officially authorized by Borden's!

Shown slightly smaller than actual size (Scale 1:24; 7½" in length).



Expertly crafted.

To replicate this nostalgic Borden's truck to perfection, the Danbury Mint has crafted this superb model in large 1:24 scale using more than 200 individual parts. Each precision part is rigorously inspected multiple times before the replica is hand-assembled. Each truck is then hand-waxed to a lustrous, gleaming finish.

Impressive attention to detail.

This model will delight even the most demanding die-cast collector. The memorable snub-nosed grille, sliding side doors, and "Elsie the Cow" logo are all authentically reproduced. The model even comes complete with 20 removable milk crates!

Attractively priced; satisfaction guaranteed.

The memories this beautiful replica will recall are priceless, but this highly collectible reproduction is available at a very attractive price. You can acquire your *1950 Borden's Milk Truck* for just $135, payable in five convenient monthly installments of $27*. If not completely satisfied, you may return your replica within 30 days for replacement or refund. Mail your Reservation Application today!

**Plus any applicable sales tax and $1.60 shipping and handling per installment.*

The model comes with 20 removable, true-to-scale milk crates, each with 12 simulated bottles.

© MBI © 1998 BORDEN INC., ALL RIGHTS RESERVED.

RESERVATION APPLICATION

The Danbury Mint
47 Richards Avenue
Norwalk, CT 06857

Send no money now.

THE 1950 BORDEN'S MILK TRUCK

Yes! Reserve my *1950 Borden's Milk Truck* as described in this announcement.

Name _____
(Please print clearly.)

Address _____

City _____ State _____ Zip _____

Signature _____
(Orders subject to acceptance.)

Allow 4 to 8 weeks after initial payment for shipment.

7423IPB2

Record-Height Thrill Ride

SANDUSKY, OH—Rising into the sky, it looks like a ride only a crash-test dummy should take.

The skyscraper-like structure at the Cedar Point Amusement Park is the tallest thrill ride the world has known. And those with the guts to experience it had better be ready for rocket-like acceleration.

The Power Tower, a 300-ft. steel structure with four elevator-like shafts, blasts riders both straight up and straight down at a force of more than 4 g's.

Using new air compression technology, two of the shafts shoot riders up 240 ft. and two plunge them down 240 ft. But you'll barely have enough time to clench your fists: Each trip only takes 3 seconds.

Thrill-lovers will strap themselves into chairs facing outward, leaving their legs dangling in the air. Then the seats blast off unexpectedly, without a countdown, as if accelerating to 50 mph in 3 seconds isn't enough to make hearts pound.

The Power Tower combines fast acceleration and weightlessness on a record-height open-air ride.

CEDAR POINT PHOTO

"On the ride that goes down, riders accelerate much faster than if they were free falling," said Stan Checketts, inventor of the air compression system that drives the Power Tower. In addition to height and speed, riders also experience a sensation usually reserved for astronauts. There's a moment of negative gravity where riders feel weightless.

The Power Tower is scheduled to rocket its first passengers this May.

Bitumen-Based Power Plant

PARRISH, FL—Trumpeting one of the newest and most controversial fuel sources in power generation, Florida Power & Light (FPL) wants to construct the nation's first bitumen-based power plant. Bitumen occurs naturally as pitch and asphalt.

In an effort to bring customer costs down, the state utility wants to convert its 22-year-old oil-burning Manatee Power Plant to one that burns a patented fuel containing a 70/30 mixture of bitumen and water.

FPL says burning this fuel—which is called Orimulsion—would reduce total air pollution emissions by 18%, while saving customers about $4 billion over the next 20 years.

"Orimulsion will provide a substantial environmental and economic benefit to the people of Florida," says FPL president Paul Evanson.

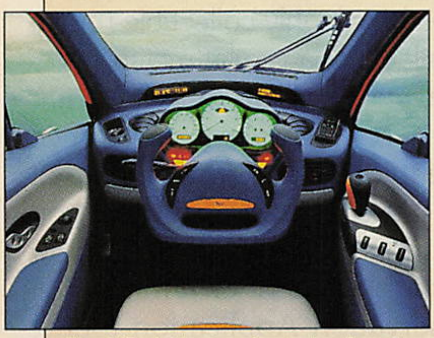
But opponents claim the fuel poses several environmental threats, such as high nitrogen oxide emissions.

The state denied FPL's first bid for the fuel conversion, but the utility is confident that its plan will be accepted after it is improved. The state should issue its ruling by April.

If Orimulsion is given a green light in Florida, other state utilities might also pursue the controversial but plentiful alternative fuel source.

High-Powered Tricycle

FRANKFURT, GERMANY—Half motorcycle, half luxury car, Mercedes-Benz's latest concept vehicle is showing the world that a tricycle is no kid's toy.



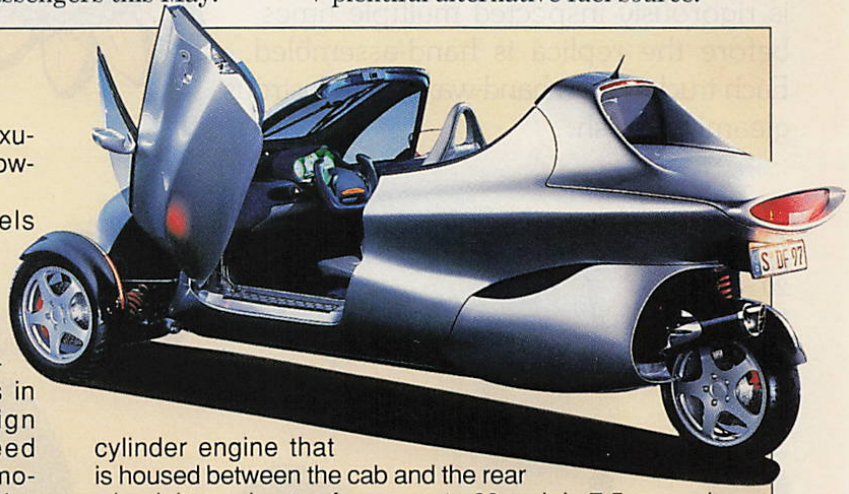
The Life Jet's steering wheel and clustered instrument panel seem fit for a futuristic spaceship.

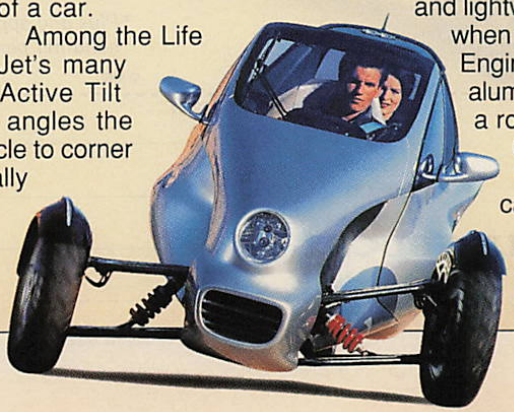
With two wheels in front and one wheel behind, the F300 Life Jet research car uses several radical new concepts in automotive design to meld the speed and agility of a motorcycle with the safety and comfort of a car.

Among the Life Jet's many ground-breaking features is its Active Tilt Control System. It automatically angles the cab during turns, enabling the vehicle to corner at forces up to 0.9 g—a turn usually limited to expert drivers.

About the same length as a full-size car, the Life Jet is powered by a 102-hp 1.6-liter 4-cylinder engine that is housed between the cab and the rear wheel. It accelerates from zero to 60 mph in 7.5 seconds and can hit a top speed of more than 130 mph. Safety and lightweight construction were top priorities when Mercedes-Benz designed the vehicle. Engineers used a space frame of extruded aluminum for the chassis and incorporated a rollover bar in case of a side collision. One passenger can sit comfortably behind the driver, and the cab's roof can be removed during good weather.

Mercedes-Benz is displaying the Life Jet at auto shows but has not yet decided if it will be put into production.





DAIMLER-BENZ PHOTOS

(More Tech Update on page 24)

HOW TO **KEEP** YOUR **NEW YEAR'S RESOLUTION** FROM GOING UP IN **SMOKE.**

1998. Looks like a good year
to quit smoking.
Why? Because it's now.
And because you have
Nicorette® gum to help you.
Nicorette lets you decide
how much nicotine you need,
and when you need it.*
And Nicorette not only helps you
stay on top of your cravings,
but when a craving hits,
it helps you get rid of it... fast...
before it gets to you.
So you can stop smoking
before more than your resolution
goes up in smoke.

www.nicorette.com
*Use as directed.

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YOU CAN DO IT.
Nicorette® can help.

PARTNERS IN HELPING YOU QUIT
AMERICAN CANCER SOCIETY®

Owens Corning scientists have virtually eliminated the itch in insulation.

Maybe we should take on poison ivy next.

Only Owens Corning innovation can offer you insulation that's virtually itch-free.

Most people just assume that insulation, like poison ivy, is going to make you itch. Fortunately, our scientists at Owens Corning challenged that assumption. After years of head-scratching research, they developed MIRAFLEX® insulation with its revolutionary, cottony soft fiber that's virtually itch-free. Then they poly-wrapped it for easy handling.

Start at the top: your attic.

Now it's more comfortable than ever to get up in the attic and install insulation for year-round savings*. The attic is where 40% of the energy is lost in a typical home. Adding *MIRAFLEX* R-25 insulation (8¼" thick) to your existing attic insulation is an easy project that can improve your insulating system year-round. Most homes need R-38 in the attic, which is equal to 12" of fiber glass blanket insulation. Our Home Energy Savings Kit offered in this ad includes the R-values recommended for your climate.

Insulating an attic is an easy do-it-yourself project that can save you plenty.*

Improve your home's insulating system, one project at a time, to save money on heating and cooling costs all year 'round.

In projects all around the house, Owens Corning offers many ways to improve your home's insulating system. Each is designed to reduce the itch. Our PINK*PLUS*® insulation products come poly-wrapped to assure "less itch"

OUTDOOR TIP

"Leaflets three, let them be." As the old saying goes, if the leaves on a plant stem are grouped in threes, chances are it's poison ivy.

PROJECT TIP

Take a few minutes to plan your insulating project and everything will go smoother. Make a list of all the steps involved and the tools required.

If you need advice, just give us a call.

*Savings may vary. Find out why in the seller's fact sheet on R-values. Higher R-values mean greater insulating power.

19-BLR-21898 Copyright © 1997 Owens Corning The color PINK is a registered trademark of Owens Corning. System Thinking for the Home is a registered trademark of Owens Corning.

during handling and installation.

Warm up to PINKPLUS R-19 insulation and say good-bye to cold floors.

Getting to the bottom of cold floors.

If your floors give you cold feet, warm them up with our PINK*PLUS* R-19 insulation (6¼" thick).

Adding value to room additions.

Enhance a room addition for long-term energy savings with PINK*PLUS* R-13 insulation (3½" thick) for 2x4 exterior walls. And add a layer of insulating system comfort with Owens Corning PINK FOAMULAR® rigid foam insulation. For 2x6 walls, use PINK*PLUS* R-19 insulation (6¼" thick).

Getting down to business in your basement.

Another simple project that can increase your home's living space is finishing your basement. Insulate those basement walls with PINK*PLUS* R-13 insulation (3½" thick) for 2x4 framing. Another easy-to-install option with plenty of insulating power is Owens Corning INSULPINK™ R-7.5 rigid foam insulation (1½" thick). Either way, your comfort will be greater during installation, and long after.

By insulating basement walls, your finished basement can feel as comfortable as the rest of your home.

Getting the shivers from drafty windows?

Replace them with energy-efficient Owens Corning vinyl windows. Our standard ¾" insulated glass helps keep indoor temperatures comfortable. And our durable sash and frame construction helps keep performance high. What's more, optional Low E/argon glazing helps keep heat from escaping in winter and keeps you cool in the summer.

Drafty windows can be replaced with high performance vinyl windows by Owens Corning.

Are energy savings hiding in your crawlspaces?

Additional savings can easily be achieved by insulating crawlspaces. *MIRAFLEX* R-25 insulation (8¼" thick) is ideal for virtually itch-free handling while insulating your crawlspace walls.

Insulating crawlspaces is a small project that can yield big results.

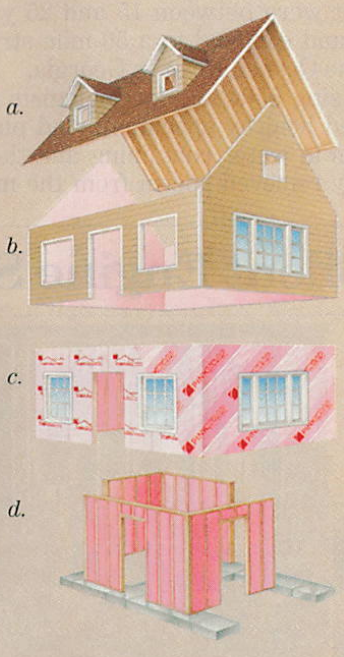
Don't give drafts even the smallest opening.

Finally, don't overlook the caulking and sealing of all cracks, joints and small openings inside and outside your home. Use non-hardening caulk in cracks. Seal those small openings tight with easy-to-apply Owens Corning Pinkseal™ foam sealant.

No matter which project you choose to do next, make sure you choose Owens Corning PINK insulating products. That's the best way to make sure your next home improvement project turns out right. With less itch.

After all, there's a system to these things.™

Your house is a series of systems. At Owens Corning, we want to help you understand how those systems work and how to make them work better. For free information or advice, call 1-800-GET-PINK *ext. 1026*



a. **Roofing System** – *Protects your home from the damaging effects of wind, rain, snow and sun.*

b. **Exterior System** – *Helps the outside of a house endure the elements beautifully, in trouble-free fashion.*

c. **Insulating System** – *Helps keep you warm in the winter and cool in the summer.*

d. **Sound Control System** – *Reduces the transmission of noise from adjoining rooms.*

FREE HOME ENERGY SAVINGS KIT

We know you're itching to find out more. For free information about our Insulating System, for a copy of our Home Energy Savings Kit, to locate a retailer, or to find an Owens Corning Certified Energy Professional insulation contractor, visit our web site at http://www.owenscorning.com *or call*

1-800-GET-PINK *ext. 1026*

OWENS CORNING

SYSTEM THINKING
for the Home™

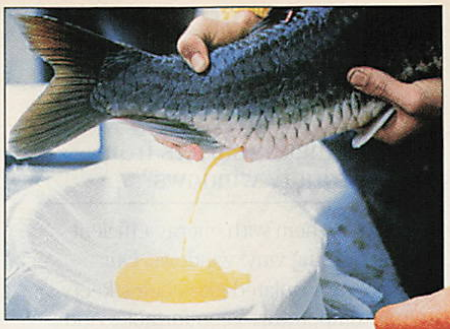
Redhorse Revival

WARM SPRINGS, GA—Electric shocks, anesthesia and fertility drugs are helping revive a nearly extinct fish.

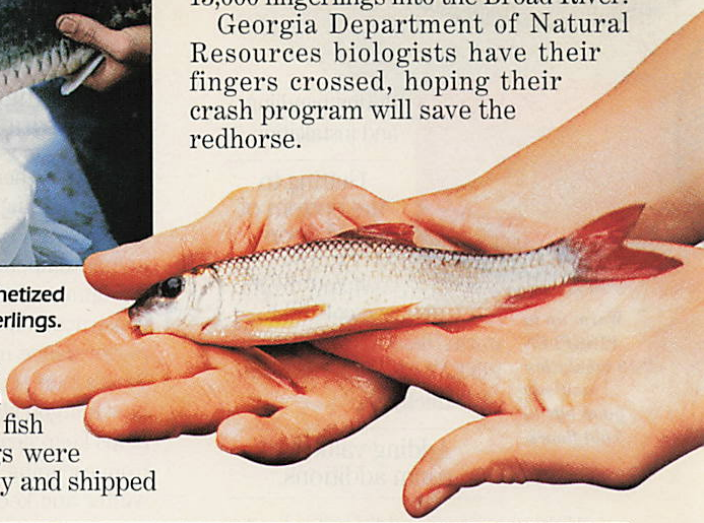
A century ago, streams in Georgia and the Carolinas teemed with *Moxospoma robustum*. Known to fishermen as the robust redhorse, the population of these large, iridescent greenish-gold fish had dropped to several thousand by last year. Worse, most were between 15 and 25 years old and confined to a 50-mile stretch of the Oconee River in Georgia.

Using 550v shocks, biologists captured healthy specimens and placed them in water containing anesthesia. They removed sperm from the males and used fertility drugs to induce rapid ovulation in the females. Captured fish were returned. The eggs were fertilized in the laboratory and shipped to a hatchery, which has now released 15,000 fingerlings into the Broad River.

Georgia Department of Natural Resources biologists have their fingers crossed, hoping their crash program will save the redhorse.

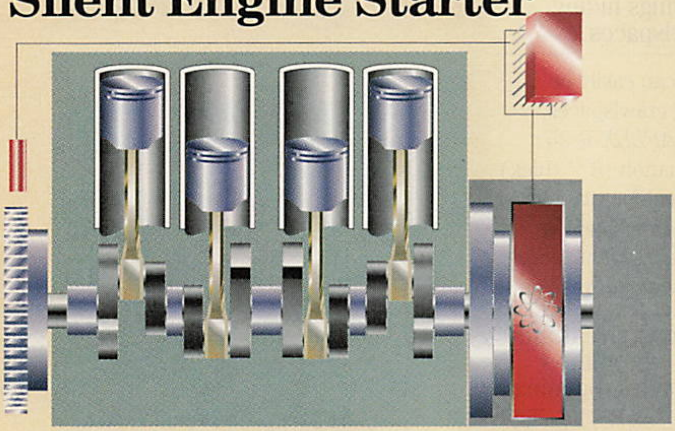


Sperm from only a few anesthetized males produced 15,000 fingerlings.



GEORGIA DEPT. OF NATURAL RESOURCES PHOTOS

Silent Engine Starter



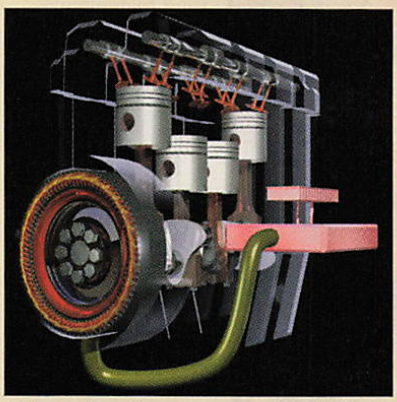
COLOGNE, GERMANY—The distinctive sound of a starter motor cranking an engine may soon fade into automotive history. Continental AG says it is testing an all-in-one starter, alternator and flywheel.

The device, which is called an integral starter/alternator/damper (ISAD), consists of a 2-in.-thick, 12-in.-dia. shaft-mounted rotor that spins inside a stator cast into the engine's bellhousing. The engine computer senses the driving condition and determines whether the ISAD functions as a motor, alternator or flywheel.

Integrating the three components offers several advantages for both motorists and manufacturers. As part of an automatic start/stop system, ISAD can produce a 30% fuel savings in urban driving. The kinetic energy stored in the flywheel can also be returned when the vehicle needs more power to accelerate. This precise second-by-second energy management also reduces emissions.

For carmakers, ISAD offers an immediate 20-pound weight savings, plus labor savings from not having to install the three separate parts.

Continental, which says it will invest $62 million in ISAD technology, hopes to have the first units available soon after the year 2000.



Information from a sensor (far left) determines the ISAD operating mode.

CONTINENTAL AG ILLUSTRATIONS

World's Longest Airliner

BOEING PHOTO

EVERETT, WA—To the accompaniment of the applause of more than 1000 employees and well-wishers, Boeing rolled out the world's longest commercial jetliner, its new 777-300.

Measuring 242 ft. 4 in. from nose to tail, the plane is 33 ft. 3 in. longer than the Boeing 777-200. Depending upon how the cabin is configured, the stretched 777 can carry between 368 to 550 passengers and travel 6450 miles.

The first plane is powered by two Rolls-Royce Trent 892 engines. Later models will be powered by Pratt & Whitney PW4090 and PW4098 engines.

Boeing began work on the plane in June 1995. After completion of flight-testing, perhaps as early as May, the first 777-300 will go into service on the Cathay Pacific Airways run to Hong Kong.

Molecular Current Measured

NEW HAVEN, CT—For the first time, researchers have detected an electric current flowing through a single organic molecule sandwiched between metal electrodes. The feat could pave the way for a radical downsizing of transistors.

"Now we are ready to go to billions of transistors on a single chip," says Mark A. Reed, leader of the Yale University development team.

The next step, says Reed, is to design computer chips whose wires are made of self-assembling strings that grow in a beaker, since the transistors would be too small to connect with wires.

(More Tech Update on page 26)

HEAR WHY THE BOSE® WAVE® RADIO WAS NAMED A "BEST NEW PRODUCT OF 1994" BY *BUSINESS WEEK*.

Tabletop radios are popular for their convenience and small size. But their sound quality leaves much to be desired. No one really expects high-fidelity sound from a radio. Until now.

Bose presents the Wave radio. It's the one radio acclaimed by leading audio critics. Because it's the one radio that delivers big, rich, lifelike stereo sound *plus* a small, convenient size.

breath of air to fill an entire concert hall, the waveguide produces room-filling sound from a small enclosure. This technology and performance is available in no other radio.

You'll touch a button and hear your favorite music come alive in rich stereo sound. You'll hear every note the way it's *meant* to be heard. The Wave radio measures just 4.5″H × 14″W × 8″D and fits almost anywhere. So you can listen in your bedroom, living room, kitchen, or any room. And with your choice of imperial white or graphite gray, the Wave radio not only fits in any room, it fits any decor.

CALL NOW AND MAKE SIX INTEREST-FREE PAYMENTS.

The Wave radio is available for $349 directly from Bose, the most respected name in sound. So call 1-800-845-BOSE, ext. R6724, to learn more about our in-home trial and satisfaction guarantee. When you call, ask about our six-month installment payment plan. Or, if you prefer, return the coupon below.

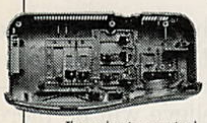
Set six AM and six FM stations.

Easily connect your CD player, cassette player, TV, or VCR.

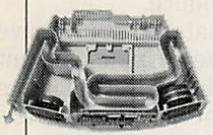
HEAR THE RADIO THAT WOKE UP AN ENTIRE INDUSTRY.

THE BEST-SOUNDING RADIO YOU CAN BUY.

We think the Wave radio is the best-sounding radio you can buy. And audio critics agree.



The speakers in conventional radios cannot produce lifelike bass, which is essential for great sound.



Only the Wave radio with acoustic waveguide speaker technology produces high-quality sound with full, rich bass.

Radio World called the sound "simply amazing...a genuine breakthrough in improved sound quality." *Business Week* named the Wave radio a "Best New Product of 1994." *Popular Science* called it "a sonic marvel" and gave it a prestigious "Best of What's New" award. The key is our patented acoustic waveguide speaker technology. Just as a flute strengthens a

REMOTE-CONTROLLED CONVENIENCE.

Operate the radio from across the room with the credit card-sized remote control. Set six AM and six FM stations, and switch between them at the touch of a button. You can even bring great Bose sound to recorded music, TV programs, or movies by connecting the Wave radio to your CD or cassette player, TV, or VCR.

Wired magazine said it has a "clean, sweet sound that will have your friends wondering where you've hidden your fancy speakers." But you have to hear the Wave radio for yourself to believe it. Call today.

CALL 1-800-845-BOSE, EXT. R6724.

When you call, ask about our six-month installment payment plan. (Available on telephone orders only.) Also ask about FedEx® delivery service.

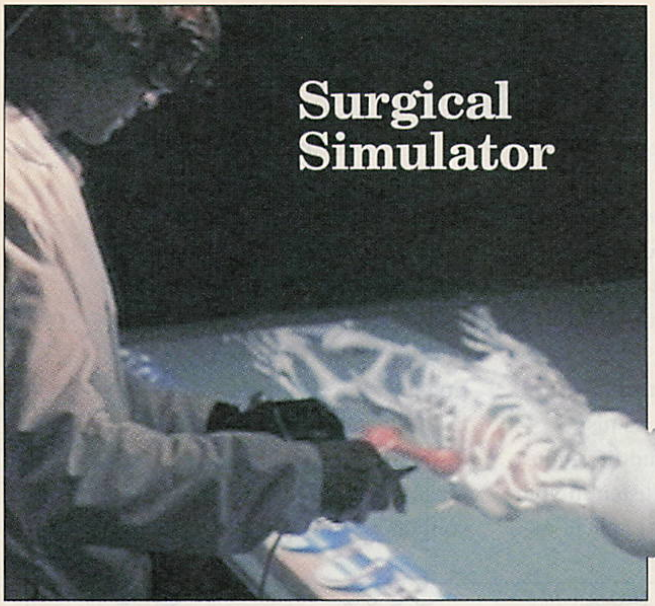
Please specify your color choice when ordering the Wave® radio:
☐ Imperial White ☐ Graphite Gray

Mr./Mrs./Ms.
Name (Please Print)
Address
City State Zip
( )
Daytime Telephone
( )
Evening Telephone

Mail to: Bose® Corporation, Dept. CDD-R6724, The Mountain, Framingham, MA 01701-9168, or fax to 1-800-862-BOSE (1-800-862-2673).

BOSE®
Better sound through research.®

©1998 Bose Corporation. Covered by patent rights issued and/or pending. Installment payment plan not to be combined with any other offer and available on credit card orders only. Price does not include $15 shipping and handling and applicable sales tax. Price and/or payment plan subject to change without notice. FedEx service marks used by permission. *Wired*, June 1994.



STANFORD UNIVERSITY/FAKE SPACE PHOTO

Surgical Simulator

MOUNTAIN VIEW, CA—Stanford Medical Center is working with NASA's Ames Laboratory to apply a tool called an Immersive Workbench to provide the most realistic virtual reality simulation of complex operations ever created.

Developed by Fake Space of Palo Alto, California, the Immersive Workbench is a 3D display platform similar in size and shape to a pool table. Users wear special 3D glasses and see 3D images that project into the immediate space above the workbench. Using a wand-like device, the image can be turned around or moved from one part of the display to another. Eventually, these images will be based on actual patient X-rays and MRIs.

"You really get a three-dimensional feel of the body when you look at it with the 3D glasses," says Muriel Ross, director of the Ames Biocomputational Center. "These surgical viewpoints can also be greatly enlarged for training and teaching, making it easier for resident doctors to understand particular anatomy segments or medical procedures."

Fake Space believes there is also a good future for its new display outside of the operating room. It is also developing systems for use in areas such as architecture, geography, engineering and military battle planning.

No Grind Dental Bridge

HONOLULU—A plastic that behaves like putty until it is exposed to light promises to take the tooth-grinding out of dental bridgework.

Traditional bridgework requires several uncomfortable sessions in the dentist's chair. Patients of Ronald S. Carlson, a dentist who practices here, typically flash their new pearly whites after a less-than-2-hour visit.

The speedy new bridges are made possible by a polymer-resin composite embedded with microscopic chips of silica, explains Carlson. Fresh from the container, the material is soft. Exposed to a bright blue light, it cures tooth hard.

Instead of grinding down healthy teeth to anchor the bridge, Carlson chemically etches the surface enamel of adjacent teeth. The replacement tooth is placed in position and fused to the adjacent teeth with resin. Finally, the hardening blue light bonds the artificial tooth to the surface of its two companions.

The whole procedure takes less than 2 hours. Even better, it's painless, so it can all be done without anesthesia.

RONALD S. CARLSON PHOTO

The gum where the missing tooth was is allowed to heal.

Artificial tooth is positioned. Anchoring resin is added.

Epoxy covers the new tooth and the two adjacent teeth.

Installation of the new tooth is complete within 2 hours.

Sound-Absorbing Spheres

ATLANTA—An insulating material first developed to withstand 2000° F temperatures may have a cool new use as a multipurpose sound-deadening material.

Ten years ago, Joe K. Cochran, a professor of materials engineering at Georgia Institute of Technology, developed the original spherical shells—which he calls aerospheres—as an alternative for industrial and home insulation.

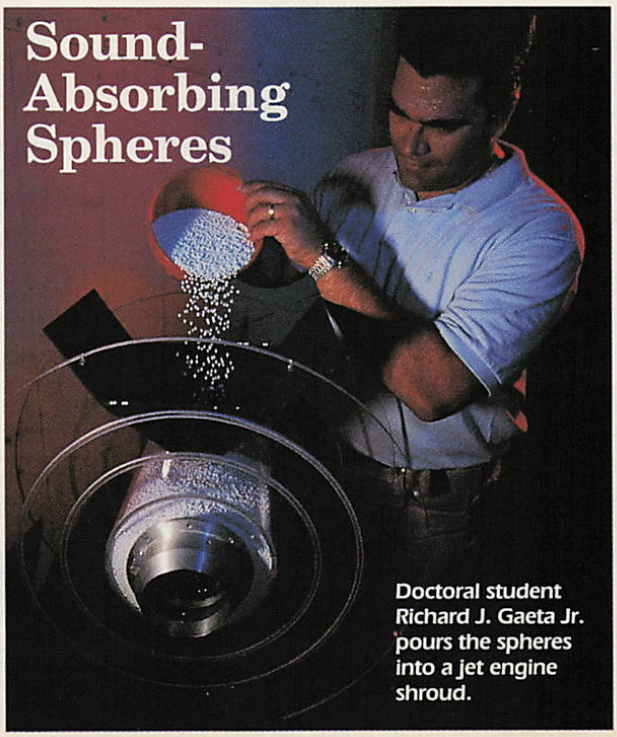
More recently, one of Cochran's colleagues, Krishan K. Ahuja, speculated that drilling tiny holes in the surface of the ceramic spheres would improve their noise absorption properties. Subsequent tests in which the hollow spheres' sound-absorbing characteristics were compared with those of solid spheres proved the idea correct.

The next step is to pinpoint exactly how the spheres reduce noise. Then, they want to conduct tests with thicker spheres—which they believe will be more durable—and lightweight plastic spheres, which would be cheaper to produce.

The new material could have widespread uses. Unlike current foam and Kevlar acoustical liners which must be preshaped, the hollow, thin-skinned spheres could be poured into existing structures, including cavities around high-temperature devices such as jet engines.

"They can be used for any situation where you need to cut down noise," says Ahuja. "They can be used for soundproofing residential and commercial buildings and quieting the exhaust systems of aircraft and automobiles. They also can be used to quiet hair dryers and pneumatic tools."

STANLEY LEARY/GEORGIA TECH PHOTO



Doctoral student Richard J. Gaeta Jr. pours the spheres into a jet engine shroud.

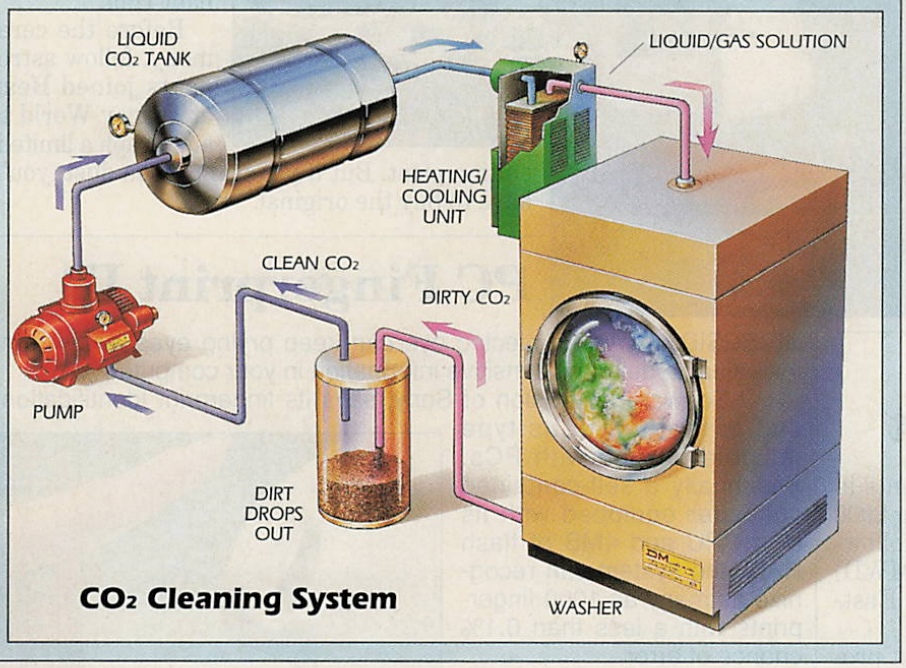
(More Tech Update on page 29)

Earth-Friendly Dry-Cleaning

LOS ALAMOS, NM—Dry-cleaners are under pressure from the Environmental Protection Agency to clean up their act by discontinuing the use of chlorine-based solvents. One solution could be only a breath away, in the form of carbon dioxide (CO_2), the gas that humans exhale.

The trick is to turn up the pressure, say researchers at the Los Alamos National Laboratory (LANL). Putting CO_2 under 800 to 1000 pounds of pressure causes it to act like a liquid. In this state it serves as an entirely recyclable solvent that extracts dirt from clothing, says LANL researcher Craig Taylor. When the liquid CO_2 is allowed to return to its gaseous state, the dirt just falls out. Repressurized, the CO_2 can be used again.

"CO_2 is better than chemicals in use now," says Taylor. "It's a better solvent, it cleans faster and it's environmentally benign." LANL is working with Global Technologies to demonstrate the process in El Segundo, California, and Santa Fe, New Mexico.



CO_2 Cleaning System

PM ILLUSTRATION BY DON MANNES

Bound For Saturn

The Titan 4-B's twin boosters gave off an incandescent light display as the rocket arced over the Atlantic Ocean.

NASA PHOTO

CAPE CANAVERAL, FL—The $3.4 billion *Cassini* mission is on its way toward Saturn. Scientists feared that protesters objecting to the 72 pounds of plutonium used to power the spacecraft might cancel the launch (see "Ring Rider," page 60, Nov. '97).

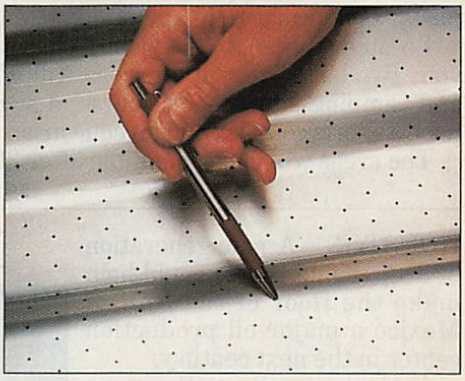
Cassini will reach Saturn on July 1, 2004. Then, in November, it will drop the European-built *Huygens* lander onto Saturn's largest moon, Titan. Meanwhile, orbiting *Cassini* also will use a special radar to penetrate the thick, orange atmosphere of Titan. Scientists expect to map about 20% of Titan's surface.

Cool Solar Panel Makes Heat, Volts

TORONTO—Researchers have found that combining photovoltaic panels that convert 10% of sunlight to electricity and space-heating panels that capture 70% as heat produce more energy savings than expected. This is because photovoltaic cells lose efficiency if they overheat.

Conserval Engineering has put this discovery to work with its new PV Solarwall panel. It's made of dark-colored corrugated steel with rows of 1/16-in. holes punched through it. The panel is heated by the sun, and air is heated as it is sucked through the holes and used for space or hot-water heating. A 100-sq.-ft. panel will collect about 32 kwh of heat and electricity in 5 hours.

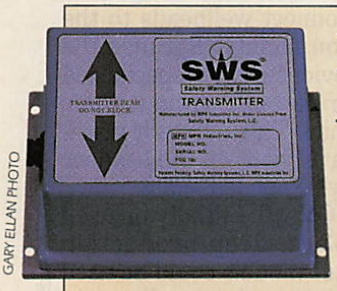
The company is now testing its technology with several types of cells.



Drawing hot air away through holes improves solar cell efficiency.

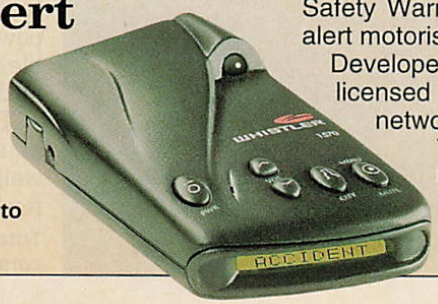
ANDY TURNBULL PHOTO

Road Hazard Alert



GARY ELLAN PHOTO

SWS has donated transmitters to state highway departments.



ENGLEWOOD, FL—The problem with highway signs is that they don't always provide sufficient time for the driver to react. Safety Warning Systems (SWS), says its new technology can alert motorists to problems a mile or more down the road.

Developed by the Georgia Tech Research Institute and now licensed to several manufacturers, the system consists of a network of transmitters and receivers.

The transmitters are mounted roadside. The dashboard receivers offer 64 different safety messages.

The most advanced receivers include a speech synthesizer that announces the messages.

JAY PENNI PHOTO

Astronaut Art

GREENWICH WORKSHOP PHOTO; SKIP GANDY PHOTO (INSET)

Astronauts who flew on Mercury, Gemini and Apollo missions signed Bean's latest painting.

TITUSVILLE, FL—There is something out of this world about Alan Bean's artwork.

Like artists of old, the former *Apollo 12* astronaut has his own personal paint recipe. His special ingredient is moon dust.

"I always wanted moon dust," Bean told PM. "But NASA didn't give us any." When he realized the Apollo, NASA and U.S. flag patches he kept from his November 1969 flight contained dust, he decided they should become part of his paintings. "I grind up a little each year," Bean says. "They look like they're half gone."

One of Bean's most recent paintings, which shows an astronaut leaping into space to touch a star, was unveiled during a ceremony at the U.S. Astronaut Hall.

Before the ceremony, fellow astronauts joined Bean at Disney World to autograph a limited-edition print. But if you want moon dust, you'll have to buy the original.

Giant Reservoir Recreation Project

DOMENIGONI VALLEY, CA—Residents in Southern California will soon be enjoying 2000 acres of new outdoor recreation space following the Metropolitan Water District's (MWD) approval of a development plan for the Eastside Reservoir.

"I don't know of any other project that proposes this many types of facilities in a single park," says project manager Dennis Majors.

Located adjacent to the main 4500-acre reservoir, two large recreation areas will offer RV and camping sites, a golf course, a swimming pool, a sports complex and an equestrian center.

The areas will open sometime after 2000.

PC Fingerprint ID

RIVERSIDE, CA—An electric eye can keep prying eyes away from the valuable data and sensitive information in your computer.

I/O Software, a division of Sony, says its fingerprint identification unit is the first of its type feasible for use with PCs. Essentially a self-contained computer equipped with its own CPU and 4MB of flash RAM, the system can recognize as many as 1000 fingerprints with a less than 0.1% chance of error.

The digital imaging device remembers your fingerprint.

SONY PHOTO

To use a fingerprint-protected system, you place your finger into a device the size of a computer mouse. In a fraction of a second, it checks the pattern of swirls on your fingertip to determine if it matches authorized users. If you're legitimate, it lets you log on. Privacy has its price, in this case about $650 per scanner.

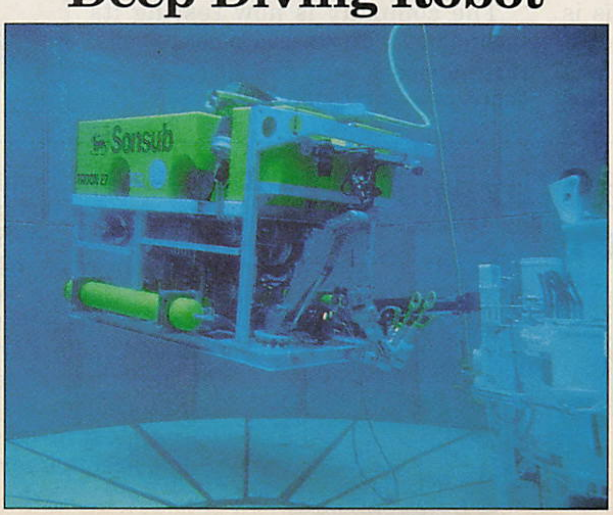
Deep-Diving Robot

HOUSTON—A new generation of deep-diving robots could help make the floor of the Gulf of Mexico a major oil production center in the next century.

Geologists estimate there are 25 billion barrels of oil hidden beneath the Gulf's deepest waters, those greater than 656 ft. Leading the race for deep water is Shell Oil Co., the Houston-based subsidiary of Royal Dutch/Shell.

To help oil companies reach this liquid treasure chest, Sonsub International has designed the Triton 27 remotely operated vehicle (ROV).

Using a 75-hp hydraulic power supply unit to control thrusters, two articulated manipulators, four video cameras, and other tools, the ROV can operate at a depth of 4500 ft. Here, it provides power and control for specialized tools which, among other things, connect wellheads to the production facility. Because the ROV provides power, specialized tools can be built without their power units. This makes it possible to leave them on the seafloor until they're needed again.



The ROV will initially be used at a 3253-ft.-deep production well. Later models could be used for 20,000-ft. or deeper dives.

Triton 27 makes underwater connections in Sonsub's tank.

SONSUB INTERNATIONAL PHOTO

(More Tech Update on page 32)

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First Digital Computer

IOWA STATE UNIVERSITY

AMES, IA—Iowa State University has built a working replica of the first electronic digital computer in an effort to honor the men who invented it.

The full-scale replica is a working model of the computer John V. Atanasoff and Clifford Berry constructed at Iowa State from 1939 to 1942.

Building the replica wasn't easy because the Atanasoff-Berry Computer (ABC), which was never patented, was dismantled. Students and faculty members spent several years tracking down original papers and photographs and interviewing those involved in the project.

ABC was a 750-pound, desk-sized mess of vacuum tubes, punch cards and circuitry. It performed one operation every 2 seconds. By way of comparison, today's computers can perform billions of operations per second.

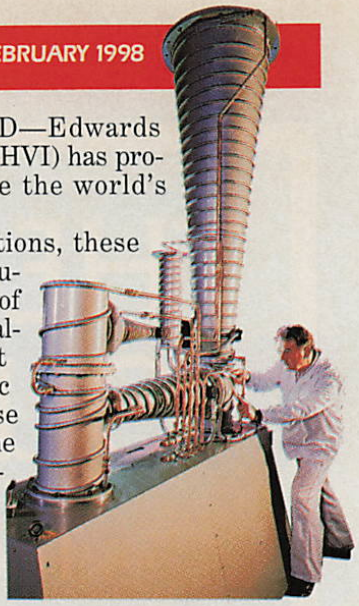
Atanasoff was an ISU physics professor who invented ABC to save his students, who included Berry, time and tedium in solving lengthy equations.

Giant Vapor Booster

WEST SUSSEX, ENGLAND—Edwards High Vacuum International (EHVI) has produced what is believed to be the world's largest vapor booster pump.

Used in industrial applications, these pumps create the massive vacuums needed for rapidly removing large amounts of gas—including explosive hydrogen. They are typically used in petroleum and chemical distillation, heat treatment, vacuum drying, degassing and plastic and paper metalizing operations. Although these pumps have widespread applications, most—like the 10-ft.-tall model shown here—have to be custom-built. Only one company, EHVI, still does this.

The crown was sufficiently impressed with the company's tenacity to award EHVI the Queen's Award for Export Achievement.



BRIAN BELL PHOTO

It took more than a wrench to change reactor valves.

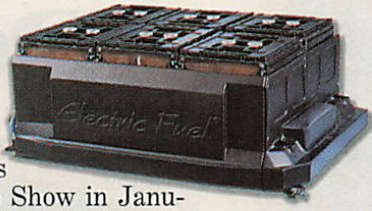
Nuclear Reactor Valve Job

BORSSELE, HOLLAND—EZP, the operators of the Borssele Nuclear Power Plant, are crowing about finishing a major plant renovation in a record-setting five months.

During the crash project, Siemens Power Generation Group refit the 24-year-old reactor with a new control room, reactor coolant system valves, and a simulator to train operators.

SIEMENS PHOTO

Electric Vehicle Update



NEW YORK—Electric vehicles are charging onto the streets. Nissan unveiled the 1998 Altra EV 4-passenger wagon at the Los Angeles Auto Show in January. Designed and built in Japan, Altra EV runs on lithium-ion batteries built by Sony and is intended for consumer and fleet use. It has a range of 120 miles and can hit 75 mph.

Altra EV (above) uses lithium-ion cells. Zinc-air batteries (right) weigh 1 ton.

Also, nonprofit New York Power Authority and Israel-based Electric Fuel Corp. plan to bring zinc/air-powered commercial vehicles to the Big Apple. Already in fleet use in Europe, zinc-air batteries run for 250 miles between charges.

ELECTRIC FUEL PHOTO (RIGHT)
NISSAN PHOTO (LEFT)

Mighty Mice

BALTIMORE—Johns Hopkins researchers have genetically engineered mice to grow Herculean muscles.

"The first thing that we noticed was that the mice had unusually large shoulders and hips," says Alexandra McPherron, a Hopkins Ph.D. who helped make the discovery. "On closer analysis, we found that all their muscles were two to three times normal size."

To create the mice, scientists "knocked out" a newly discovered gene called growth/differentiation factor 8 (GDF 8). Erasing GDF 8 from the rodents' genetic code removed the normal limit on skeletal muscle growth. "Except for the muscles, the mice appear to be normal and healthy," says McPherron.

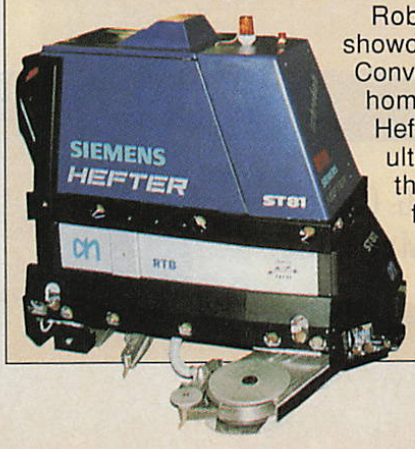
Researchers say the mighty mice experiment may lead to the development of treatments for muscular dystrophy and other muscle-wasting diseases.

Cleaning Up

HANOVER, GERMANY—The butler knocked them dead at this year's Hanover Trade Fair.

Robo-butler was built by Siemens Corp. to showcase its expertise in artificial intelligence. Conventional cleaning robots find their way by homing on beacons. Siemens fit a standard Hefter Cleantech unit with electronic gyros and ultrasound and laser scanners. Comparing these real-world measurements with data from an electronic digital map keeps it from knocking over exhibits.

A commercial version of Robo-butler is now being tested as an aisle cleaner by a German supermarket chain. TU



SIEMENS PHOTO

SHIP MODELING...

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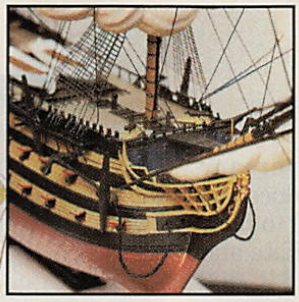

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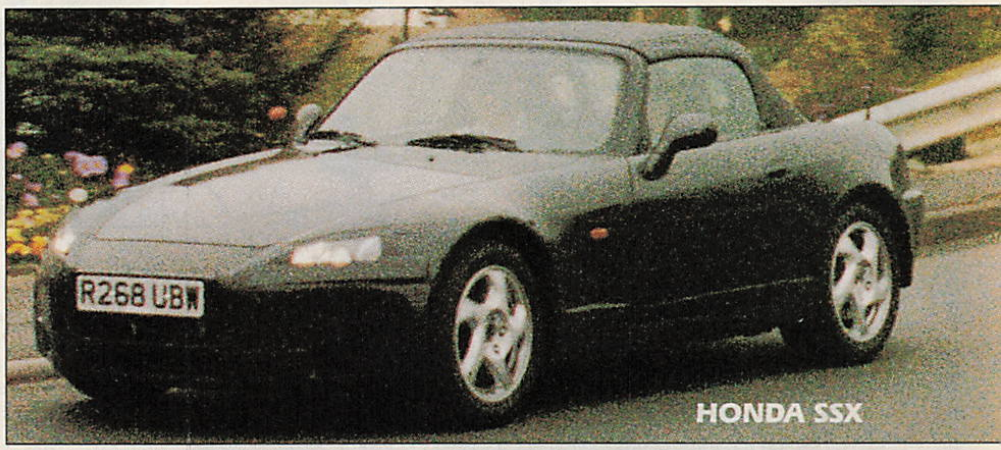
Asia Spy Report

BY SCOTT OLDHAM, West Coast Editor

Honda SSX

● As part of its 50th-anniversary celebration, Honda will introduce the SSX, a rwd roadster intended to blow the doors right off Mazda's Miata and undercut the price of the $40,000 German roadster trio by $10,000 to $15,000. Power will come from the 2.2-liter VTEC 4-cylinder that drives the Prelude, but the engine will produce more than that car's 195 hp. There will be a manual and auto-manual offered. The engine is mounted behind the front axle to achieve ideal 50/50 weight distribution for optimum handling. The 2100-pound car will also have a double-wishbone suspension with aluminum bits, standard traction control, ABS and electronic drive-by-wire. You can expect to see the Japan-built SSX here as a 1999 model.



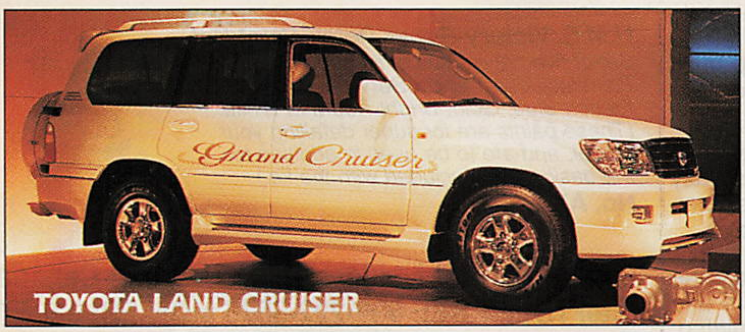
HONDA SSX

Suzuki Sidekick

The big news on the '99 Sidekick is its optional dohc 2.5-liter V6 engine. Also of importance is the vehicle's new name—which is a better-kept secret than the formula for Coca-Cola. Oh, we almost forgot, there's also a total redesign, but more about that later.

Standard power in both the 2- and 4-door body styles will be a dohc 140-hp Four. The V6, which will make about 160 hp, will only be available in the top-of-the-line 4-door, which will also get sporty body cladding and fender flares.

The redesign makes the 4-door about 2.5 in. longer, 2 in. wider and 3 in. higher than the present Sidekick, which means more rear-seat legroom and more shoulder space. The rear door swings open, rather than up. Chevy will still get a version they'll call the Tracker, but they will not get the V6.



TOYOTA LAND CRUISER

SUZUKI SIDEKICK

Toyota Land Cruiser

Often dubbed the Land Crusher, this year the king of Asian SUVs will get the engine its deserves: a V8. The dohc 4.7-liter V8—which will also find a home in the T100 pickup and the Lexus LX 470, the Land Cruiser's snooty twin—should make something in the order of 225 to 235 hp. Called the Grand Cruiser at the Tokyo Motor Show, the new Cruiser gets more interior room and a muscular new look, but it still remains recognizable as a Land Cruiser.

Isuzu VehiCROSS

Isuzu will start building wildly styled sport/utility vehicles in small volumes at its plant in Lafayette, Indiana, starting in November 1998. The first will be the VehiCROSS.

A new process using ceramic stamping dies allows Isuzu to produce molds cheaply. The molds wear out after only 3000 units, but they can be changed at very low cost, making frequent design changes and special models possible.

When U.S. production on the '99 VehiCROSS begins, it will look basically the same as this vehicle, but it will use the Amigo chassis. After 3000 VehiCROSSes are built, the Zaccar, a 3-door SUV with a crazy-looking stacked front end, will be built on the Amigo chassis. Its third door is much like the one on 3-door pickups. PM

ISUZU VEHICROSS

BERND RAUH PHOTO (TOP), PM PHOTOS BY BILL DELANEY (CENTER), MARK WILLIAMS PHOTO (BOTTOM LEFT)

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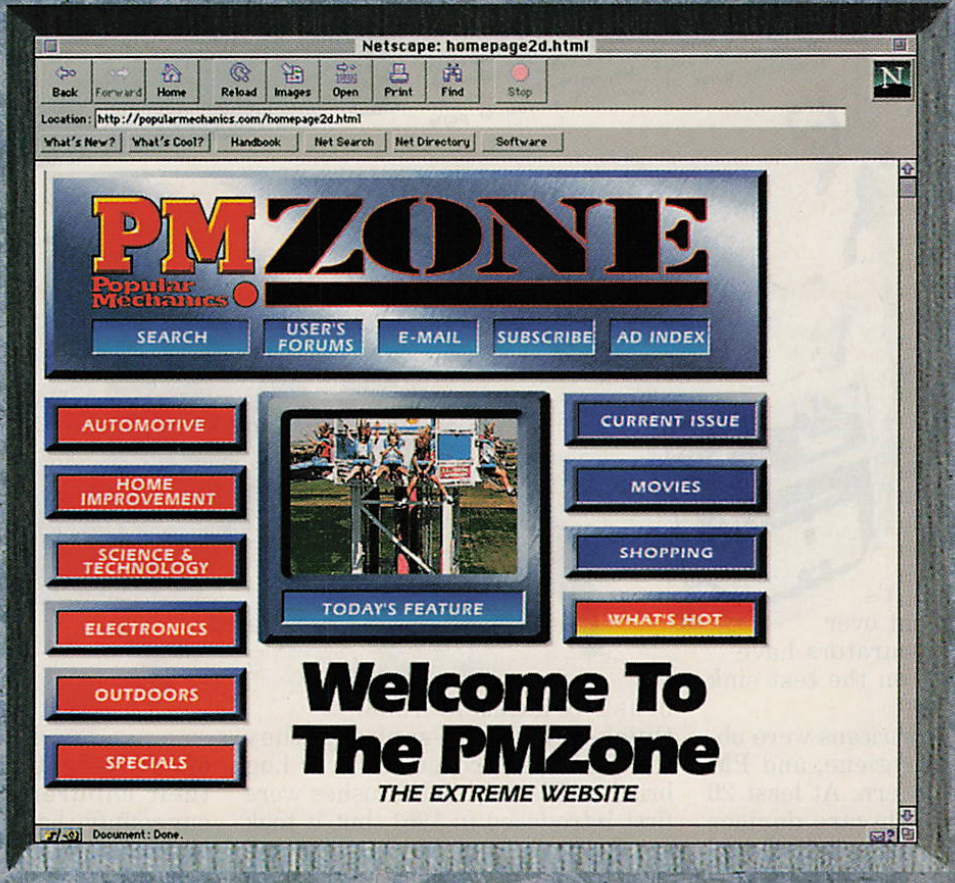

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TECHNOLOGY

Think It's New? Think Again!

The mechanical way to whiter teeth.

BY MARY SEELHORST

PRESENT • Inventing a better toothbrush is a lot like inventing a better mousetrap: It's easy to say you've done it, but it takes a while to prove it. Yet that doesn't stop people from trying.

Putting a new spin (pun intended) on American dental hygiene, Interplak came out with the first rotary-action toothbrush for home use in 1987, featuring bristle clusters that rotate 4200 times a minute. Braun-OralB hit the U.S. market in 1991 with a slightly different angle—the whole head rotates. No longer mere "toothbrushes," the "instruments" of today are intended to clean the teeth and massage the gums. Maybe they should add a tachometer.

PAST Think buffing teeth to a spit shine is a new idea? Think again!

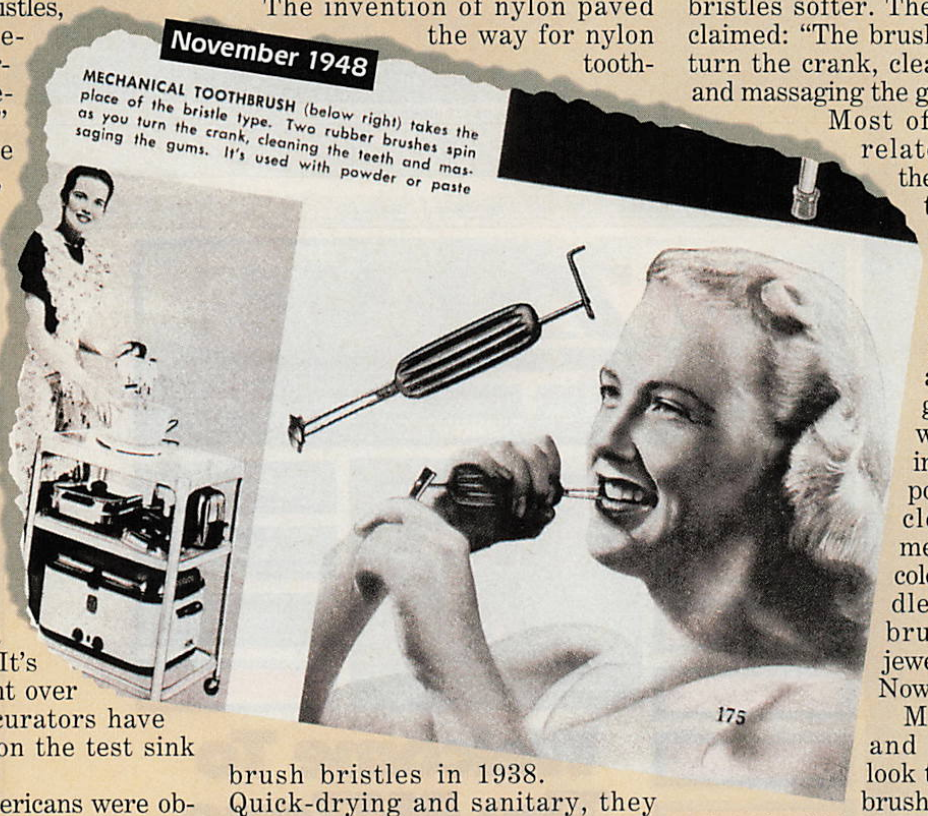
"Rotary Toothbrush Gives Aid To Dental Hygiene" was a headline in the January 1928 POPULAR MECHANICS. Looking like a small pogo stick, the toothbrush had a hand-activated, spring-loaded screw built into the handle. Squeezing and releasing turned a wheel of bristles, "saving hand movements and more thoroughly cleaning between the teeth." Perhaps it saved one kind of hand motion, but a teeth-brushing fanatic like myself might find carpal tunnel syndrome an unpleasant side effect, especially trying to hit 4200 rpm.

The National Museum of Dentistry, in Baltimore, Maryland, has in its collection a Zerbee rotating toothbrush from 1930, a wind-up number with a round brush head. It's a clear improvement over pump-action, but curators have yet to take it out on the test sink and clock its speed.

In the 1920s, Americans were obsessed with oral hygiene, and PM reflected their concern. At least 20 new ideas for tooth-care devices appeared in PM between 1920 and 1930. Among the claims: "Ultra-Sanitary Toothbrush Has Removable Bristles," "Rubber Disks In Toothbrush Replace Bristles," "Tongue Cleaner On Handle Of Toothbrush," and "New Toothbrush Sterilizer Keeps Brush Sanitary." One brush looks remarkably modern, with a wavy bristle pattern said to provide "better cleansing of the teeth." Toothpaste dispensers, rubber toothpicks and cleverly disguised travel toothbrushes were also popular in the 1920s.

The invention of nylon paved the way for nylon toothbrush bristles in 1938. Quick-drying and sanitary, they were a big improvement over hog bristles. Electric toothbrushes were first introduced in 1961, but it took some people a while to overcome their reluctance toward putting an electrical device in their mouth.

Yet, as PM reported, electricity isn't necessary for rotary bristle action. Neither are nylon bristles. Another early entry into the rotary market was featured in PM in 1948. It had a small crank that was turned with one hand while the other hand held the brush in place. It had rubber brushes, even though nylon brushes were getting more and more common in the late 1940s as manufacturers found ways to make nylon bristles softer. The manufacturer claimed: "The brushes spin as you turn the crank, cleaning the teeth and massaging the gums."


November 1948
MECHANICAL TOOTHBRUSH (below right) takes the place of the bristle type. Two rubber brushes spin as you turn the crank, cleaning the teeth and massaging the gums. It's used with powder or paste
175

Most of PM's dental-related articles in the 1950s mirrored the do-it-yourself bent of that era. They included plans for making toothbrush holders and clever suggestions for new ways of dispensing toothpaste or powder. One article even recommended using the colorful plastic handles of old toothbrushes to make jewelry for children. Now that's recycling!

Modern fathers and mothers can look to clinical toothbrush trials for proof of cavity-fighting effectiveness for their children, but the father of our country had no such recourse. If he had, perhaps his wooden dentures wouldn't have ended up enshrined in the National Museum of Dentistry—along with his last real tooth. **PM**

PANASONIC PHOTO (TOP)

MONEY BACK GUARANTEE!

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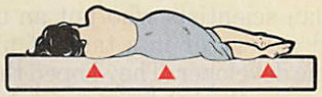

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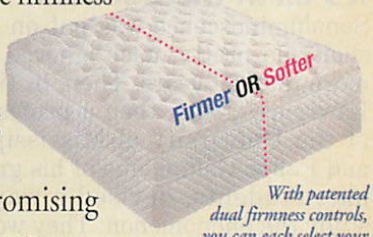

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SCIENCE

Hot Sounds

BY JIM WILSON, Science/Technology Editor

● Sonoluminescence isn't a household name, but it could soon shake up the world of nuclear physics.

Sonoluminescence, or light from sound, was first observed in 1934 by German scientists who put an ultrasound generator in a tank of photographic developer. They hoped that vibrating the fluid at frequencies higher than humans can hear would speed up the development process. Instead, the emulsion-coated plates emerged with spots. On closer inspection, they found that when the ultrasound generator was turned on, the bubble-filled fluid emitted a faint glow. It was this light that damaged the plates.

All of this was very intriguing. But with digital computers yet to be invented, there was no way to study the unwieldy mass of short-lived bubbles in the developer fluid.

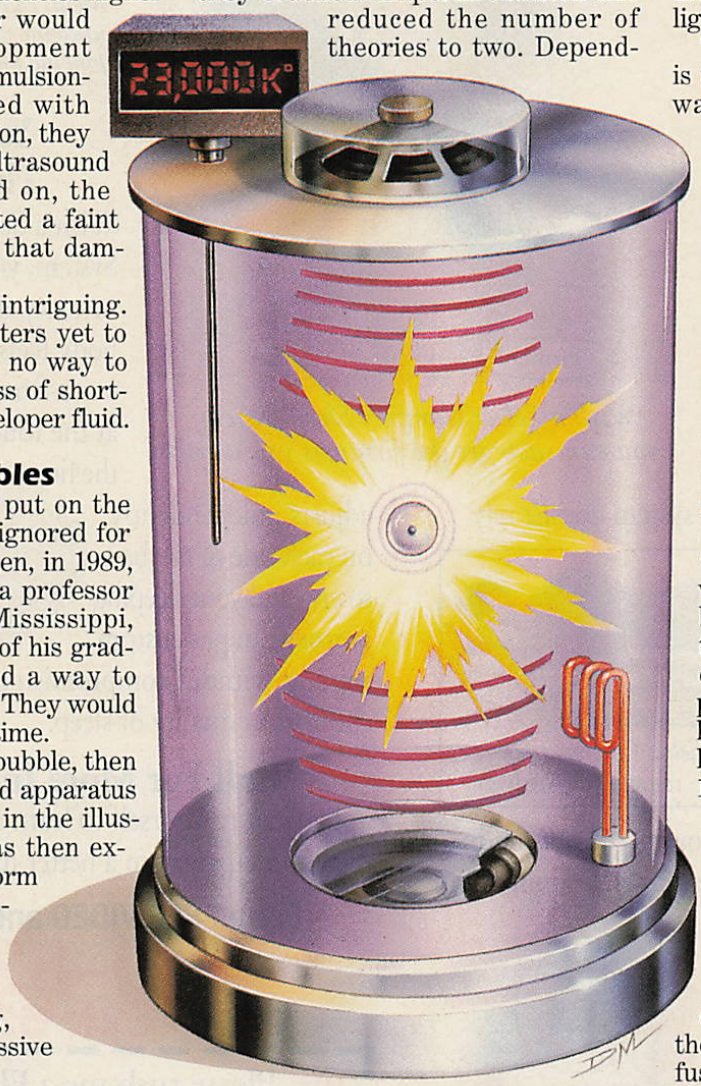
It's all in the bubbles

Sonoluminescence was put on the shelf and pretty much ignored for more than 50 years. Then, in 1989, Lawrence Crum, then a professor at the University of Mississippi, and Felipe Gaitan, one of his graduate students, devised a way to study the phenomenon: They would look at one bubble at a time.

First they created a bubble, then they used the ultrasound apparatus to position it as shown in the illustration. The bubble was then exposed to sound in the form of a continuous sinusoidal, or oscillating, wave. The bubble responded to the expansive phase by growing, and then to the compressive phase by shrinking.

When Crum and Gaitan successfully induced sonoluminescence in a single bubble, they immediately realized that single-bubble sonoluminescence (SBSL) is very different from the multiple-bubble variety the Germans had observed. What made SBSL different also makes it more than a laboratory curiosity. SBSL was hot—hot enough to melt steel and perhaps even fuse atoms. Did someone say fusion?

As word of the experiment spread, theorists attempted to make sense of it all. At one point there were more than a half dozen explanations for SBSL. They ranged from simple ideas that attributed the energy release to the effects of the bubble folding in upon itself to theories that a few molecules of water froze and flashed as they cracked. Experimentation has reduced the number of theories to two. Depending upon which is correct, sonoluminescence will be a very useful new research tool, or something that revolutionizes the way scientists study nuclear physics.



The simple equipment needed to create and study sonoluminescence can be built for several thousand dollars.

Snapping Silly Putty

The more modest explanation has been proposed by Andrea Prosperetti, an expert on the mechanical properties of bubbles at the Johns Hopkins University. Prosperetti believes SBSL is caused by a tiny jet of liquid that shoots across the interior of the bubble and slams into the opposite side at supersonic speed. "At the point where this powerful jet strikes the bubble wall, it 'fractures' the liquid, releasing energy in the form of light," he explains.

"What you see in sonoluminescence is the initial result of this hammer of water," Prosperetti says. The jet, moving at perhaps 4000 mph, strikes so quickly that the water molecules do not have time to flow away from the point of impact. Instead, the fluid fractures. "This is what happens with Silly Putty. If you pull slowly, it just stretches or flows. But if you pull it really hard, it snaps, and you get a brittle fracture," he says.

If matter is hot and radiating light, its color reveals its temperature. Hence, the blue flame of a stovetop burner is hotter than the orange glow of a birthday candle. Get a fire stoked hot enough and it will produce a light too energetic to be seen by the human eye. Sensors tuned to these invisible colors, however, can be used to determine temperature. If Prosperetti's theory holds true, the heat inside the collapsing bubbles would peak at about 10,000° F.

Prosperetti's explanation rules out the most exciting prospect for SBSL—the possibility that it could be used to generate the 4,000,000° F and higher temperatures needed to achieve nuclear fusion. "It is enough to explain the chemical activity, but it's far below the amount needed to produce nuclear fusion," says Prosperetti.

Before Prosperetti offered his "snapping Silly Putty" analogy, there was a growing scientific consensus that the bubble suspended in the center of the SBSL apparatus glows because of shock waves that concentrate energy in its center as it rapidly shrinks.

Prosperetti and others disagree with this idea because they believe it would be physically impossible to maintain the spherical shape of the bubble as it compresses. But William C. Moss, a physicist at the

PM ILLUSTRATION BY DON MANNES

Lawrence Livermore National Laboratory who studies what happens when materials are briefly exposed to sudden shocks, doesn't see this as all that daunting a challenge.

Moss and his colleague Thomas J. Matula, a recent presidential science award winner, are currently working on developing a method of enhancing the collapse of the bubble as it undergoes the rapid expansions and contractions that characterize SBSL. "The idea is to add an extra kick at the critical moment," Moss explained. This kick would provide the energy needed to fuse deuterium (heavy hydrogen) into helium, which liberates a lot of energy.

Hot or cold

The question of what constitutes a lot of energy has caused a public relations problem for researchers. It began when sonoluminescence took center stage in a science-fiction movie titled "Chain Reaction," which portrayed it as a sort of son-of-cold-fusion process that would liberate massive amounts of energy from bubbling tap water.

For the scientists who worked on real SBSL, "Chain Reaction" was a genuine horror movie. In the first place, any type of fusion that takes place inside the experimental apparatus is conventional hot fusion. Moss explains that a representative fusion reaction consists of two deuterium nuclei fusing to create a helium nucleus and a neutron and a very small amount of energy. The details get complicated, but they're important.

"Hydrogen comes in a few flavors, or isotopes," explains Moss. "Every flavor always has one proton. What differentiates the flavors is the number of neutrons." Normal hydrogen has only one proton. Heavy hydrogens—deuterium or tritium—also have neutrons. Deuterium has one neutron, tritium has two. Only these heavy hydrogens can participate in fusion reactions.

"Fusion temperatures always strip the electrons from the hydrogen atoms, so we are concerned only with the nuclei," Moss says. It is the nuclei that fuse to create heavier elements.

"A reaction that we are interested in is the fusing of two deuterium nuclei into a helium nucleus," explains Moss. "Now, helium also has different flavors. Each flavor has only two protons. It is the number of protons that determines which element you are dealing with. It is the number of neutrons that determines which flavor you have."

These reactions conserve particles so that two deuterium nuclei (proton plus neutron and proton plus neutron) fuse to form helium-3 (two protons plus a neutron), plus a neutron, plus 3.2MeV of energy. "Although it is certainly not obvious, since the particle numbers are conserved, there is 'missing mass,' which accounts for the 3.2MeV of liberated energy," says Moss.

"If you actually 'weigh' the reactants and products you will see that there is a real mass difference. This mass difference appears as the 3.2MeV of energy per reaction," he says. A thermonuclear explosion occurs, but it is confined to a handful of atoms, so that only a very small amount of energy is released.

The bottom line is that the amount of energy released is too little to even heat water, let alone create the spectacular explosions that had viewers of "Chain Reaction" on the edges of their seats. Some researchers have calculated that an ocean-size SBSL system running at full tilt wouldn't generate enough hot water to brew a cup of coffee.

For this reason, no one believes it will be possible to generate commercially useful amounts of power from SBSL-induced fusion. If, however, the temperatures needed to fuse atoms can be achieved, it would be possible to perform the type of research that can now only be done with multi-billion-dollar particle accelerators, using tabletop equipment that costs only a few thousand dollars.

SBSL's future

Even if SBSL cannot be used for generating fusion-triggering temperatures, it offers a wealth of other applications. The relatively modest power consumption of an SBSL-based chemical detoxification system, for example, would make it possible to build portable units that could be used to dispose of nerve gas in shells or containers that are too unstable to move.

SBSL also has promising applications in an emerging field known as sonochemistry. The flashes of light that are characteristic of SBSL occur fast enough to observe some types of chemical reactions as they occur. And, the energy release by SBSL is enough to force new types of chemical reactions, such as preventing iron, which normally has a crystalline structure, from crystallizing as it solidifies.

Acoustics researchers have suggested that the burst of energy could be used as the "ping" of a new type of sonar system, one so powerful it would not only be able to bounce signals off the ocean bottom but also penetrate into several feet of sand below.

Most important of all, the recent discoveries involving SBSL serve as a reminder: Nature is filled with useful surprises for those who are willing to look close and listen well. **PM**

PM HOTLINES

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Detroit Spy Report

BY JIM DUNNE, Detroit Editor

CHEVROLET SUBURBAN

1999 Chevrolet/GMC Suburban

● As sales of big pickups and sport/utility vehicles heat up, so does the competition. To help counter the success of Ford Expedition/Lincoln Navigator, GM is overhauling its line of C/K pickup trucks and the SUVs built from their platform. Both Chevrolet and GMC models will be changed, and they'll feature big new V8s as well as improved diesel engines. This Suburban was found during a hot-weather towing test—note the horse trailer attached to it—in the Southwest. Despite the masking and camouflage, you still get a hint of the shape of the grille and nose, and it looks much like the front end found on the new GMC Denali.

New Ford F-150/250

Ford will perform a minor facelift on its best-selling F-150/250 line of pickup trucks when the 1999 models are unveiled later this year. While the changes *appear* slight from a distance, up close you see a completely new face, including grille, bumper and lower fascia. Most noticeable is the deeper grille opening that drops into a sagging bumper. This unofficial photo shows the F-250 version. Changes to the F-150 are identical. Look for the hot-selling Ford Expedition to offer similar changes, except for minor differences in the grille texture, in 1999.

FORD F-250 PICKUP

Plastic Windows

Eventually you'll be looking out through plastic windows in cars. They'll appear first on sport/utility vehicles and minivans. Automakers think that the fixed rear-quarter windows on those vehicles are ideal for determining how well plastic will hold up in customers' hands. The installations won't be ready until after model year 2000. Polycarbonate is one material that has an excellent chance of becoming a glass replacement. It is now being used as backlites on some convertible models or as T-roofs where visibility and abrasion resistance are not critical.

Ford Escort SVT

Among the new Escorts planned by Ford is an SVT version. This Escort coupe, spied near Detroit, sports larger wheels and tires than normal. Beneath the red sheetmetal are performance-boosting upgrades to the suspension and engine. After the success Ford has found with its SVT version of the Contour, it seems natural to try the same hop-up treatment for the youth-oriented, affordable Escort.

Future Grand Cherokee Springs

Word on the street has it that Chrysler will spring a surprise when it introduces the revamped Grand Cherokee next year. In place of steel coil springs, Chrysler engineers are planning an air-over-oil or an all-oil suspension system for the future sport/utility. In addition to the ride improvement, the new suspension will give Grand Cherokees an exclusive that other SUVs can't match, including a number of ride settings: soft, standard and firm. Also, the big Jeep will have the ability to raise or lower its body, a benefit when driving off-road or on the freeway. Air-over-oil is not new. It was used in the 1950s in Citroën sedans with mixed results. Yes, the ride on those cars was limousine smooth. But the extra cost and questionable reliability worked against the system's widespread use. PM

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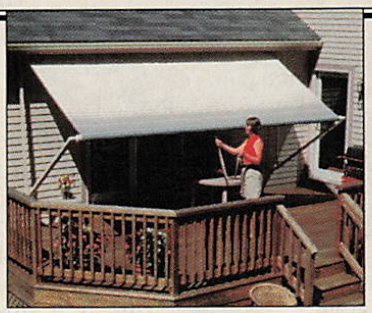

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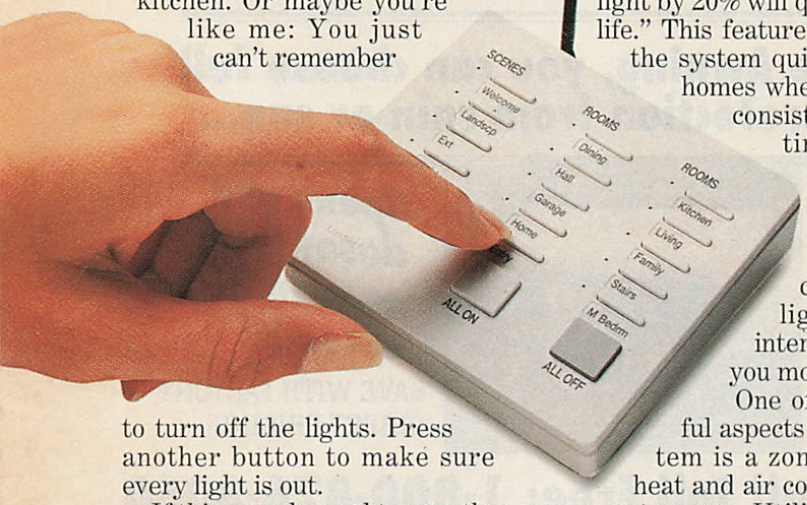
ELECTRONICS

Mood Lighting

BY TOBEY GRUMET, Electronics Editor

● Did you ever wake up in the middle of the night with a hankering for a peanut butter sandwich? Now you can just press a button on a small keypad next to your bed to turn on the lights leading straight to the kitchen. Or maybe you're like me: You just can't remember to turn off the lights. Press another button to make sure every light is out.



If this sounds good to you, then you must be a control freak. And home-automation technology is definitely for you. With it, you control your home with the touch of a button.

Both wired and wireless systems are available and each one performs an array of feats you may previously have thought were strictly movie special effects stuff.

For instance, Vantage, based in Orem, Utah, manufactures a wired home-automation system that controls your entire home—from light fixtures to audio/video equipment to heating and air conditioning. The system's advantages include reduced energy consumption and added livability and luxury.

When it comes to lights, the Vantage system controls dimmable and settable fixtures, and, according to Vantage, "dimming a light by 10% will double your lamp life while dimming a light by 20% will quadruple your lamp life." This feature alone should make the system quite popular in those homes where family members consistently neglect shutting off lights when they leave a room. Lights can also be programmed to turn on and off at certain times, and to light up at different intensities, again saving you money.

One of the most thoughtful aspects of the Vantage system is a zone setup to control heat and air conditioning in different rooms. Utilizing motion detectors, door contacts or stress sensors under the floorboards, just walking into a room can raise the heat or air conditioning to any set level.

The system is powered by a master controller—one in smaller homes, many in larger ones—using solid-state components. It also has 250 built-in time functions that can use an infrared remote control as well as a keypad.

Initially, the house is set up with a PC, which defines how many keypads or motion detectors are needed for your home. The controls are programmed with Windows-based proprietary software. The program is then downloaded to the master controller and the PC is disengaged.

What makes this system original is its 2-wire station bus architecture. This architecture is nonpolarized, which basically means that it's extremely hard to mess up the installation. As long as you don't meld the two wires together, everything's fine. (Competing systems have a minimum of three wires, and they must be wired in a certain sequence.) What makes this possible? Something called Time Division Multiplexing, which sends the power and control signals across the same two wires, taking up less space.

In terms of wireless systems, Coopersburg, Pennsylvania-based Lutron Electronics has a control setup it calls the Radio Ra system, after the benevolent Egyptian sun god Ra.

Radio Ra is a radio frequency lighting control system, controlling dimmers and switchers through a high-frequency radio signal (418 MHz). Most importantly, it's great for existing homes as well as new homes because you don't need more rewiring. And you don't need to build this system into your home.

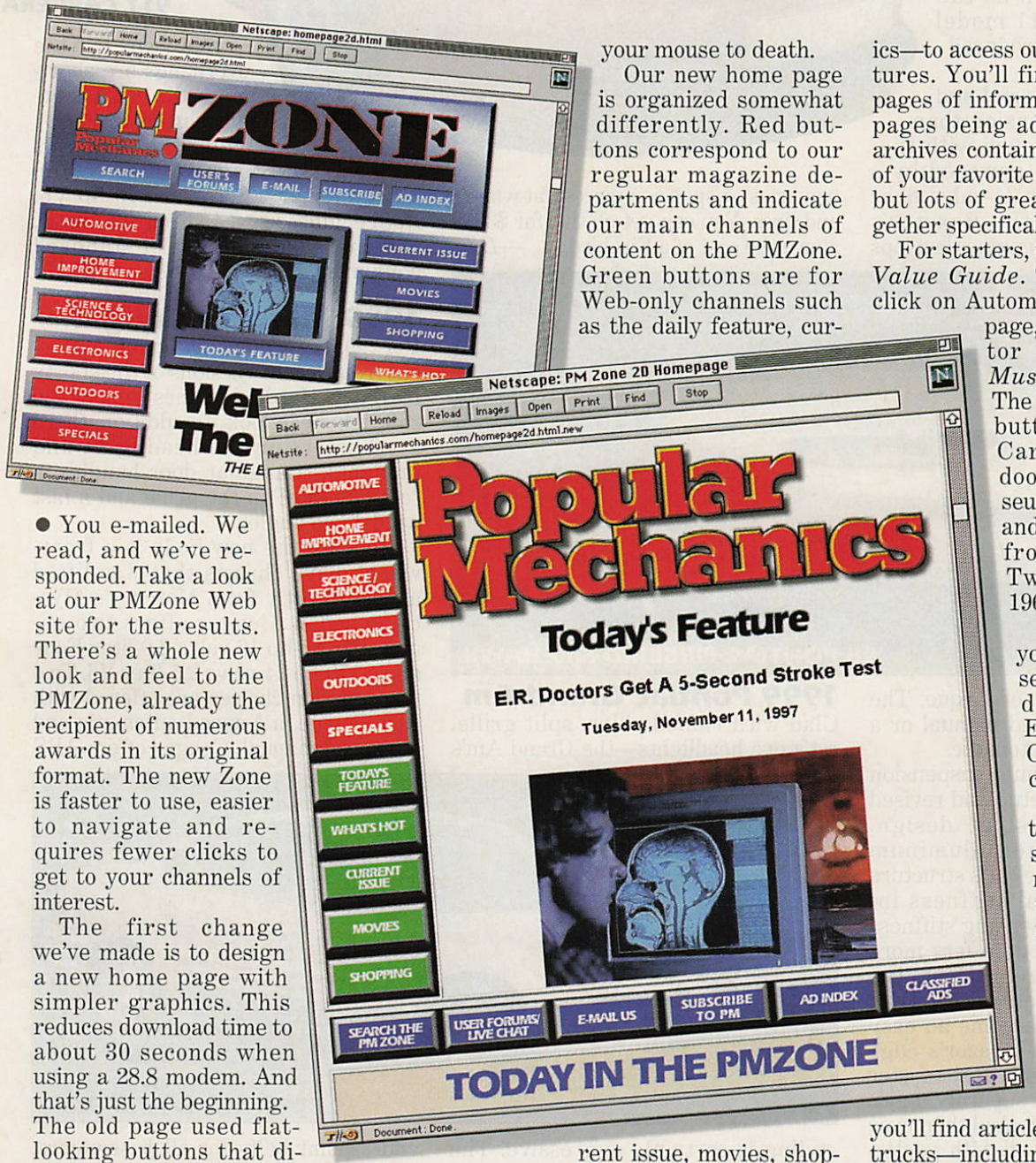
The system can handle any home from 3500 to 5000 sq. ft., and 12 master controls can communicate with 32 dimmers at one time—great for security purposes as well as plain old luxury. The Radio Ra Repeater safeguards the system by resending each command, making sure everything is communicated properly.

Install either of these systems and take control of your life. PM

LUTRON ELECTRONICS PHOTOS

Meet The Brand-New, Friendlier PMZone

BY CLIFF GROMER, Contributing Editor



● You e-mailed. We read, and we've responded. Take a look at our PMZone Web site for the results. There's a whole new look and feel to the PMZone, already the recipient of numerous awards in its original format. The new Zone is faster to use, easier to navigate and requires fewer clicks to get to your channels of interest.

The first change we've made is to design a new home page with simpler graphics. This reduces download time to about 30 seconds when using a 28.8 modem. And that's just the beginning. The old page used flat-looking buttons that directed you to the various PM departments. The system worked well for users familiar with the way we have our departments arranged in the magazine. But users not familiar with the arrangement might have scratched their heads a bit before figuring out the navigation. Now, our new buttons have a 3D feel to them. More important, we rethought the button functions so you can navigate to your destination without clicking your mouse to death.

Our new home page is organized somewhat differently. Red buttons correspond to our regular magazine departments and indicate our main channels of content on the PMZone. Green buttons are for Web-only channels such as the daily feature, current issue, movies, shopping and more. Blue buttons across the bottom of the screen handle functions such as search, chat, e-mail and classified ads.

Scrolling down the home page speeds you to a list of current articles you want to read no matter what channel they're on. Of course, you can browse in our regular channels by clicking on the red buttons—Automotive, Science/Technology, Home Improvement, Outdoors and Electronics—to access our huge archive of features. You'll find more than 10,000 pages of information, with additional pages being added every day. The archives contain not only a collection of your favorite PM editorial content, but lots of great stuff we've put together specifically for the PMZone.

For starters, there's our *Musclecar Value Guide*. To get to the guide, click on Automotive from the home page, then click on Collector Cars and then on *Musclecar Value Guide*. The Collector Car Profiles button on the Collector Cars page opens the door to a veritable museum of fantastic classics and collectibles ranging from a 1932 Packard Twin Six Coupe to a 1964 Pontiac GTO.

As a matter of fact, if you own a collector car, send a good photo and description to PM's Editor-In-Chief, Joe Oldham, and we will consider adding it.

If auto racing is your thing, click on Motorsports from the Automotive page to access the race calendars of more than 30 different motorsports series.

How about new cars? Simple. Just click on the New Cars And Trucks button from the Automotive page. Here you'll find articles about new cars and trucks—including the complete POPULAR MECHANICS *1998 New Cars and Trucks Buyers Guide*. We even show video footage of many of this year's hottest vehicles.

What hasn't changed on the PMZone is the incorporation of new technology in building a world-class Web site.

We hope you enjoy the new home page, and let us know if there is something else we can do to make your time in the PMZone even more fun. **PM**

SIEMENS MEDICAL SYSTEMS INC. (INSET PHOTO)

New Cars

'99 PORSCHE 911 CARRERA

1999 Porsche 911 Carrera

● Porsche has given us the first totally new 911 model since the car was introduced 34 years ago.

Lighter, more powerful and larger in every dimension than before, 911 shares much with the Boxster. Carrera is powered by a water-cooled 3.4-liter 24-valve dohc "boxer" similar to the Boxster's motor. The Carrera's engine develops 296 hp and 258 ft.-lb. of torque. The car gets a new 6-speed manual or a 5-speed Tiptronic S automatic.

The new all-aluminum suspension sports a 5-link rear setup and revised front MacPherson-strut design. Brakes have 4-piston aluminum monobloc calipers. The car's structure has had its torsional stiffness increased by 45% and bending stiffness by 50%. That new body offers more room, amenities and refinement. The new 911 is a more refined car than ever. Driving it has become an easy pleasure rather than a razor's edge thrill ride. It's still plenty fast—faster than ever. It handles superbly, more predictably and sure-footed than ever before. Yet it does it all with gentlemanly manners and none of its old grizzly bear attitude. *—Don Chaikin*

'98 PONTIAC FIREBIRD FIREHAWK

1998 Pontiac Firebird Firehawk

When it comes to horsepower, more is almost always better. That's the essence of SLP Engineering's version of the Pontiac Firebird, the Firehawk. For '98, Firehawk gets 327 hp from GM's LS1 V8—17 more than last year. There are more goodies, including a new nose, suspension pieces, fat wheels and tires. You can get all this for $3999 above the cost of a Firebird. *—D.C.*

1999 Pontiac Grand Am

Clad with ribbed sides, split grille, cat's-eye headlights—the Grand Am's styling is certainly aggressive. The new suit covers a completely new chassis and interior. Grand Am has a 32% increase in body stiffness, 3.6 in. more wheelbase and 3.3 in. more front track. This is a truly roomy car, but the overhangs are shorter, so the car has actually shrunk a bit.

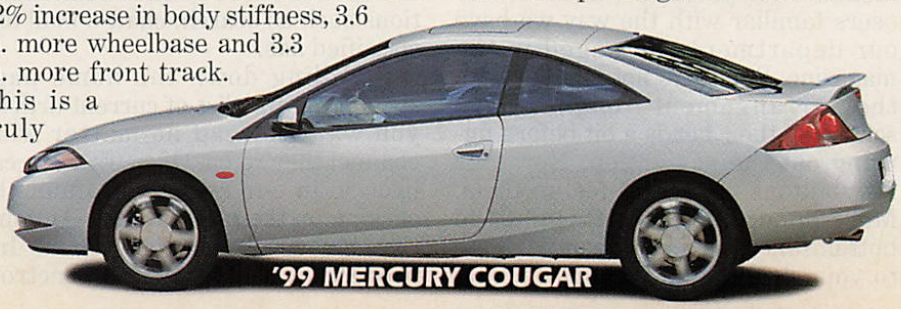
Under the hood is either a Twin Cam 2.4-liter 150-hp 4-cylinder or a 3.4-liter 170-hp V6. Both engines use a 4-speed automatic, and there's a long list of standard equipment. *—Scott Oldham*

'99 PONTIAC GRAND AM

1999 Mercury Cougar

For '99, the Cougar is hugely different from recent versions of the sporty Mercury. Hard-edge lines replace the soft, jellybean look. In addition, there are blisters on the headlights and taillights, triangular door handles, a "cat-like face" in the grille and a fast windshield angle.

Beneath the new body is a front-wheel-drive chassis that was lifted almost directly from Mercury's Mystique sedan. Cougar offers two engines: a 125-hp 16-valve 2.0-liter Four and a 170-hp 24-valve 2.5-liter V6. Two transmission choices are offered with each engine, a 4-speed automatic and a 5-speed manual. Cougar offers ABS and 3-point belts for all passengers. Safety options include side airbags for front-seat passengers. *—Jim Dunne*



'99 MERCURY COUGAR

PM PHOTO BY LES BIDRAWN (PORSCHE)

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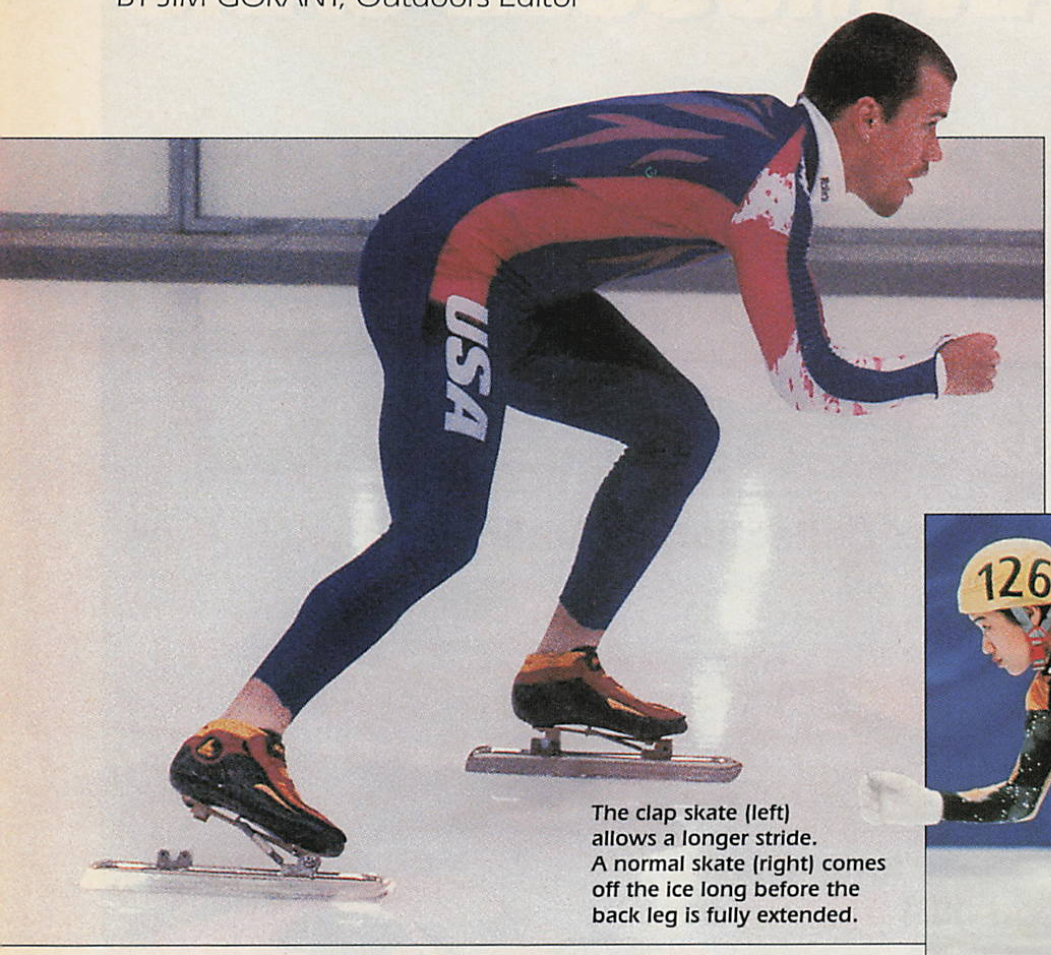
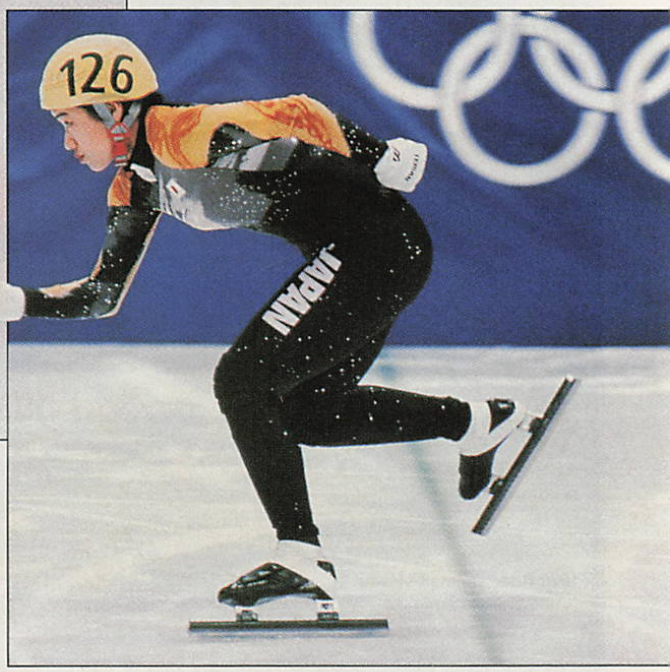
Hinge Benefits

BY JIM GORANT, Outdoors Editor





The clap skate (left) allows a longer stride. A normal skate (right) comes off the ice long before the back leg is fully extended.

● At this year's Winter Olympic Games in Nagano, Japan, speed skating will be a truly international competition. But the contest might be more technological than athletic. A new kind of skate is changing everything about the sport, from the way it's performed, to the standards of excellence, to the way it sounds. But the skates are so new and the manufacturers so overwhelmed that all skaters may not have access to the equipment. Some traditionalists wish no one did.

The new skates, known alternately as clap skates or slap skates, have a spring-loaded hinge on the toe that allows the heel to pull away from the blade at the end of the stride. This motion keeps the blade in contact with the ice longer and delivers more power per stride. As the blade snaps back into place, it creates the loud clap that led to the skate's name and forever eliminated the sport's gentle whooshing melody.

Skaters using the new skates have been dominating competition. At last year's World Single Distance Championships, 13 of the 16 men that qualified in the 5000 meters were on clap skates. Clap skate users also won first and third in the women's All-Around World Distance Championship. "We saw skaters medal this year who had never been a factor before," says U.S. skater Casey FitzRandolph, "and the difference was definitely the clap skate."

For the world's top skaters, the message is loud and clear: clap or be heard from no more.

Applause

In 1488, Leonardo da Vinci, the Renaissance visionary who foresaw the coming of the tank, the parachute and the water turbine, studied speed skating. But like one of his artworks, Leonardo finally dropped the subject when he could find no way to improve it. In fact, the sport of speed skating has not undergone a significant technological alteration since before Leonardo's time.

The seeds of change were planted in the early '80s by a team of Dutch scientists. According to J.J. de Koning, a member of that team, the eureka moment came while comparing the differences between jumpers and skaters. Jumpers, it was noted, extend their ankles, flexing their calf muscles and pushing off their toes. Speed skaters keep their ankles locked and push off their heels, because pushing off their toes would cause the blade tip to dig into the ice and slow them down.

Based on these observations, the team theorized that a skate that allowed ankle flexion while keeping the blade parallel to the ice could produce faster times by creating a longer stride that included the calf muscles. The clap skate did just that.

Although the skate showed great promise, during the subsequent 10 years the team had a hard time selling it to the skeptical and tradition-bound skating world. The mechanism itself proved delicate and tuning it was a challenge. But the team continued making improvements and testing the skate. Skaters who used the new skates showed improvement, but top-level international skaters were still reluctant to try them.

Finally, in the '94-'95 season, 11 Dutch junior skaters agreed to use the clap skates. The group improved their times by an average of 6.2%, compared with 2.5% for normal skaters. The three highest-rated skaters in the group—ranked eighth, 11th and 36th in their respective divisions—were all ranked No. 1 by the end of the season and two of the three went on to win the

CHRIS CORSMEIER/NYT PERMISSIONS PHOTO (TOP LEFT)
ALLSPORT/VANDYSTADT PHOTO (TOP RIGHT)

Dutch All-Around Championships for their age group. These results cried out for international attention, and when three women on the Dutch national team made the switch, the world heard the future of speed skating.

Clap on

"The skaters who used the clap skates this year went almost a second faster per lap," Bonnie Blair, the five-time Olympic gold medalist told the *New York Times* earlier this year. "In 1998, I think the athletes who use clap skates will rewrite the record books," Blair says. "But I'm not a big fan of the clap skate because it's a mechanical device."

Indeed, many of the top skaters seem to feel that the clap skate's technological superiority makes up for inferior technique, which is why they have resisted the new equipment. German skating star Gunda Neiman even went so far as to declare the skates illegal and say they should be outlawed, but the International Skating Federation has approved the clap skate for all competitions.

Considering this reluctance in the top skaters, it's not surprising that younger skaters who haven't spent as much time perfecting their technique on the old skates have spearheaded the clap skate insurgence. Their success is making the skates a necessity for all, including Neiman, who switched to clap skates late last season. "It's unfortunate," says FitzRandolph, "because most of the skaters and coaches really don't like them, but if the United States wants to be competitive, we are going to have to have these skates."

But for the U.S. team, getting the skates proved harder than deciding whether or not to use them. Viking, the major Dutch manufacturer of the skates, was already backlogged with orders, and the U.S. order went unfulfilled for several months. Meanwhile, teams that already had the skates were making modifications and improvements that would render the American skates obsolete by the time they arrived.

Finally, U.S. Skating decided to have the skates produced domestically. Jim Easton, a U.S. member of the International Olympic Committee and owner of Easton Sports, volunteered his company's services. Working hard, Easton's engineers were able to get a home-grown version of the clap skate onto American feet by early summer.

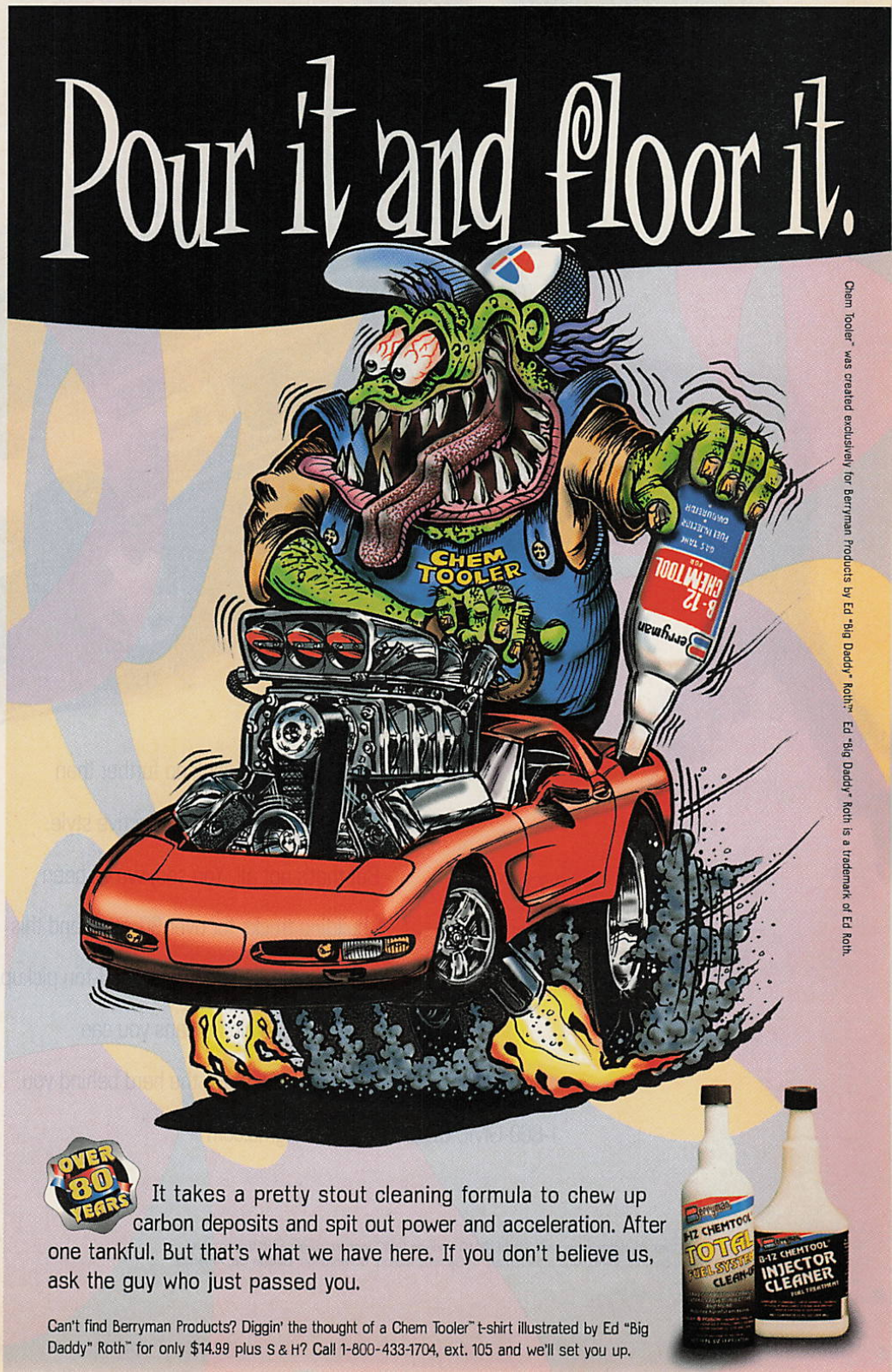
A lost art

One thing the Americans do have going for them is All-Around coach Gerard Kemkars. A transplanted Dutchman, Kemkars was one of the skaters who experimented with clap skates as a youth. He knew that getting the skates early was important because it takes several months to adapt to the clap skate technique, if it's possible at all. It also takes time to fine-tune the skates to each skater's stride and style.

As the games begin, no one knows if there's an advantage for skaters who have had the skates longer, either because they've had more practice or because they've modified the skates. But a haunting reality looms for athletes who have dedicated their lives to the sport: the race for Olympic gold may have been won on the drawing board, not the ice.

de Koning, who helped develop the skates, disputes that outlook. "The slap skate is meant to enable the skater to 'slap on' an extra amount of work per stroke," he says. "Note, however, that this extra work is not free. One has to have the physical capacity to increase the work per stroke and the mean power output in order to skate faster." In other words, it still comes down to who's the best skater.

But one question remains. Isn't introducing a mechanical device into a sport that never required anything but sharpened steel, frozen water and painstaking effort a little like painting a mustache on the Mona Lisa? PM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Popular Mechanics
FEBRUARY 1998

WEB vs. NET

As Microsoft's WebTV gears up to take on Thomson's new Network Computer, here's what you better know when the dust clears.

BY REBECCA DAY

● They've got modems, memory, microprocessors and keyboards. But don't call them computers. They plug you in to the World Wide Web and you can use them to exchange e-mail. But instead of using a full-fledged computer, they do it all with a little black box, your faithful TV set and a phone line. They're part of the new revolution of "smart" gadgets allowing even those of you with little to no technical ability to become part of the ever-broadening, supercool Internet subculture.

WebTV—both Classic and the new Plus—and the fledgling Network Computer are most definitely computers, but their marketers want you to see them in a rose-colored light—to think of them as friendly extensions of the TV, like a VCR or gaming system with an extra blast of entertainment power.

WebTV

WebTV Plus licensees Sony, Philips and Mitsubishi share the following components: a 167-MHz 64-bit MIPS processor, 1.1GB hard drive, 56kbps modem, a video modem that handles a 10Mbps data feed, 8MB SDRAM, 2MB ROM for initial boot-up and a custom ASIC called Solo, which delivers advanced graphics, video effects and image enhancement. WebTV claims Solo's 3D graphics engine delivers special effects that rival those produced by studio-quality special effects equipment.

Keeping WebTV's computer power a secret is tough because while WebTV and its licensees trumpet the muscle of the second-generation system, they don't want to conjure up images of computers. "I hesitate to talk about the hard drive because of the image that it invokes," says Greg Gudorf, director of digital media product marketing at Sony.

The hard drive in WebTV Plus enables the box to run graphics more quickly by caching information on the drive. Each night, the service automatically downloads graphics and refreshed TV listings to the receiver. With information stored to disk, subscribers don't have to wait for the receiver to connect to the Internet. "The hard drive has opened a world of applications to us," says Phil Goldman, co-founder and vice president of engineering for WebTV. "We can bring down Web pages and schedule them, and because they're already there on disk, people can access them immediately."

Goldman compares the WebTV Plus experience to that of using a CD-ROM. He credits the vast bandwidth of the video modem for making it possible. "Video modem enables us to deliver multiple gigabytes of information to disk every day." The modem is one-way but it will enable the company to deliver video clips and full-length movies to subscribers when it's ready to launch in 1998. WebTV's VideoFlash technology uses MPEG1 video compression to deliver digital video to the TV using minimal storage. First-generation WebTV owners see a graphic of a moving road as they wait to connect to the server. VideoFlash enables the company to send 15 seconds of video to viewers instead. How those video clips benefit the WebTV customer remains to be seen. It's 15 seconds with a captive audience, and the revenue potential is huge. "Maybe it will be a trailer for an upcoming movie, maybe it will be an ad, or maybe it will be something more personalized based on what I'm using on the Net," says Sony's Gudorf. For customers looking for info on jazz, it could be information about an upcoming jazz concert, or a jazz special on TV. Or it could just be an advertisement for the phone company.

It's also up to TV programmers to make content available for WebTV Plus Crossover Links, which connect viewers to Web sites that relate to a particular TV program. An "I" appears on-screen indicating there's related program information on a Web site. By clicking a matching "I" button on the remote control or keyboard, you're linked to the site. During a Sony demonstration of a prototype INT-W200 WebTV receiver last October, one of the few available crossover sites was tied to the HBO movie "Stepping Out." The linked site simply listed other versions of the classic movie along with actors, dates and related information, but the potential of the links concept is enormous.

WebTV envisions a link between televised football games and related Web pages that supply statistics, player rosters and even instant replays using WebTV's video capability.

Broadcasters who support the crossover-link feature send URL data along with programming over the vertical blanking interval, Line 21, in the NTSC signal. The "I" icon appears both on the electronic program guide and in the corner of the program itself. When viewers click the icon on the remote control, the TV picture remains active while the receiver's modem dials into the Internet via WebTV's network of 30 Internet service providers.

WebTV was purchased by Microsoft in August of last year and, so far, the subsidiary is remaining rooted in its Palo Alto digs. In the near term, WebTV will benefit from Microsoft's evangelism and relationships with content developers, Goldman says. During 1998, engineers will work on running WebTV on the WindowsCE platform. "WindowsCE will provide richer experiences like games and other active, dynamic content," Goldman adds.

The Network Computer

While WebTV receivers meet hardware parameters established by

WebTV, the Network Computer (NC) has an open architecture that will take many shapes and forms in the years to come. RCA's NC set-top box is the first on the market. It includes a $299 receiver with wireless keyboard that dials into the NetChannel monthly subscription service.

Under the hood, the RCA NC packs a special-purpose 48-MHz Acorn Computer RISC processor, 5MB RAM, 8MB ROM and a 33.6-kbps modem. "It's a very small microprocessor that requires very little in the way of associated memory," says Lou Lenzi, vice president of multimedia services at RCA parent Thomson Consumer Electronics. "It's more of a single-purpose, low-end computing platform," he says. Graphics coming off the Web are converted to NTSC in the box. If you want, however, you can go straight to VGA via a VGA port. There's also an expansion slot for an optional ROM card for future applications. The NC is positioned as a tool that uses the Internet to enhance the entertainment experience, rather than simply as a Web-browsing device. "We would like viewers to use the Web as a resource and not necessarily as a destination," says Jim Gustke, vice president of marketing for NetChannel Inc.

NetChannel's peg is its personalized information service built around the My Channel concept. Using "personal assistant" software from U.K.-based Autonomy, NetChannel downloads information nightly that's based on interests you've conveyed to the NC. You indicate your approval of an item by clicking a box that reads "I like this." The My Channel portion covers six popular topics: news, finance, sports, entertainment, lifestyles and learning.

The personal assistant is a software agent that has the ability to identify word combinations similar to the way the human brain works. The agent sorts through text, seeking unique combinations of words and then prioritizing them. "If the personal assistant reads through an article and sees the words 'car' and 'garage' next to each other, it gives out a low priority because it's a fairly common occurrence," Gustke says. "But if it sees 'car' and 'dinosaur' next to each other, it's going to remember that because it's different." The assistant culls information provided by NetChannel partners including, among others, USA Today, SportsTicker, Quicken, CDNow, WeatherLabs Inc. and The History Channel. There's also a Yahoo search engine for viewers who want to venture out to the Web on their own.

Another personalization feature is Personal Picks, which delivers stories to your receiver based on previous consumption. "Depending on where you go and the type of stories you like to read within NetChannel, we can deliver to you suggestions of other related information you might care about," Gustke says.

A third tier of personalization is Hot Topics, which is less customized to a particular viewer but still uses agent technology to deliver a string of stories based on what the agent finds. Topical news that a NetChannel editor feels is relevant to the service at large becomes an independent channel that's covered for days or weeks. Hot Topics are managed by human editors responsible for keeping channels up-to-date and relevant.

The other major draw of the NetChannel service is the electronic program guide. Viewers tell the box which cable company they use and the service delivers the corresponding program guide. Viewers can program the VCR to record a show by highlighting the name on the guide and clicking on a RECORD button. Subscribers can also sort programs alphabetically, store favorite channels and group programs by genre. You can also jump to related Web sites from the program guide. The RCA NC is the first of many different products that will use the Oracle Corp. Network Computer concept of client-server computing. "There's a shift taking place in how we think about computing that's away from a general-purpose computer called a PC and toward what's called an NC," Lenzi says. "An NC uses the power of the network to drive the cost of the terminal-level hardware to a point that's affordable and accessible to more people."

What that means is that you get to pick the flavor of NC you want—kitchen-based screen phones, informational NCs for the study, and entertainment-based NCs built into DSS, DVD and HDTV. Happy picking. **PM**

ULTIMATE HIGH

Civilian pilots shred the sky in military combat jets—for fun.

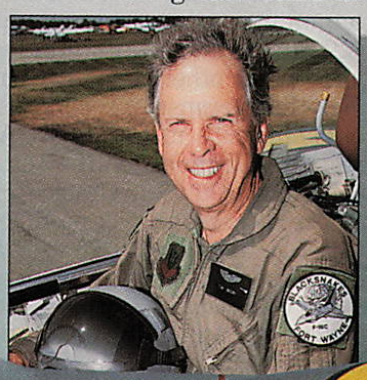
BY CLIFF GROMER, Contributing Editor

● The airspeed needle sits at Mach 0.8, but I don't really feel the speed. What I do feel in the back seat are the g's—5.5 of them, to be exact, as the pilot pulls back on the stick and the nose points at the planets and arcs us through a loop maneuver. Then it's the jetobatics equivalent of "As The World Turns." Stick jammed to the right, the L39 Albatros combat jet fighter rolls hard, and the sky and landscape start chasing each other in a mad frenzy.

Man, keep your videogames, there's nothing like the real thing.

The real thing could well be a combat mission in the Mideast with some hotshot Top Gun kid up front. But today, it's a thrill ride over Ann Arbor, Michigan. And the L39 is being put through its paces by a civilian, Bob Lutz, vice chairman of Chrysler Corp. And Lutz isn't alone in the friendly skies probing the limits of combat jets—and his own skills.

With the economic stability of the former Soviet Union continuing to unravel, all kinds of military hardware—including MiGs and other eastern bloc military fighter jets/trainers—are ripe for the picking at fire sale prices. Fueling a new trend, the demand for military jets by civilian pilots is taking off, and aviation brokers are snapping them up by the squadron. Imported



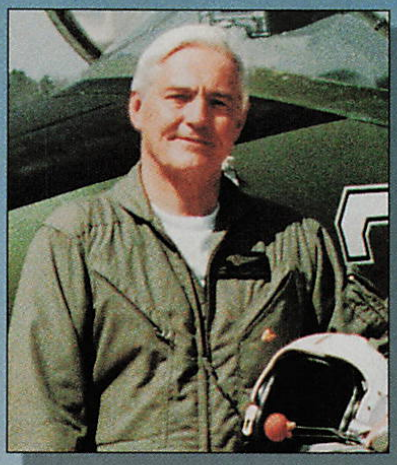
Tom Wood (left) restored this F-86 Sabre Jet and won Best Jet honors at the '93 Oshkosh air show. The warbird is capable of Mach 1 going downhill.

PHIL HIGH PHOTO (TOM WOOD); MIKE STEINEKE PHOTO (F-86)

into the States, the planes are reconditioned and lined up like used cars. The only things missing are the balloons and "one-owner cream puff" signs.

What about the stigma attached to former enemy planes bearing the dreaded red star? There isn't any. These aircraft are now considered the spoils of (the cold) war. To aviation enthusiasts, an airplane is an airplane regardless of creed or national origin. Performance, not politics, is what flies.

The appeal of fighter jets is universal. The ultimate high-performance machines, they blend fantasy, heritage and pure thrills with a healthy dollop of g-forces.



When the Viper GTS just isn't fast enough, Chrysler vice chairman Bob Lutz cranks up his L39 Albatros.

Lutz, a veteran Marine pilot with about 2500 hours in a half dozen different fighters ranging from a North American SNJ-4 to a Douglas A-4 Skyhawk, knew the L39 as an attractive design and good performer. And while he regularly hones the edge of his psychomotor skills by blasting through the twisties on a Kawasaki Ninja bullet bike, he missed the adrenaline rush of flying fighters.

A call to International Jets told him that about a dozen L39s were for sale. "Send us a deposit and we'll hold one for you," they said. What about spare parts? International Jets had worked out a clever solution. It simply bought the East German air force's entire parts inventory. The company also hired a former Soviet air force major as an instructor.

For the military pilot, it's an office. For the civilian pilot, it doesn't get any better than this.

International Jets Inc., in Gadsden, Alabama, is one broker that will sell you any number of foreign fighter/trainers such as the Czech-built L39 Albatros. According to company president R.H. Beaver, International Jets has established contacts in Russia, Poland and other countries. These contacts work with local air force base commanders to see what aircraft may be available. A group of planes is then contracted, disassembled, packed into 40-ft. containers, shipped to Charleston, South Carolina, and then trucked to International Jets' hangar in Gadsden. Foreign military planes are imported into the United States under the auspices of two agencies—the ATF and the State Department. The FAA also joins the party.

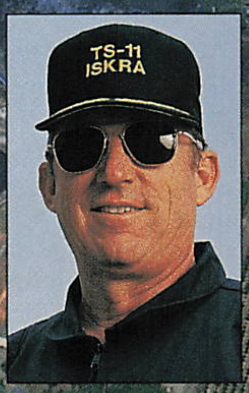
International Jets advertises its wares of war in general aviation classifieds such as *Trade-A-Plane*. That's where Lutz saw the company's ad for an L39 Albatros.

Lutz picked up his L39 in November '94 for about $220,000 and began training the following March. His Russian instructor was an excellent pilot, but the instructor's English at the time was on the level of "No, no! I show!" Lutz also taught the Russkie a few tricks of his own from his Marine flying days.

Like all foreign military jets, it's not the initial cost that socks you, but the fuel bills. The L39 burns about 130 gallons per hour, with jet-fuel pump prices between $1.50 and $2.00 per gallon. What Lutz gets in return is 4000 pounds of thrust from his single-fan jet engine—good enough to rocket his 8000-pound warbird to about 450 mph in level flight.

The flight today is anything but level. Lutz is smooth and precise on the controls, rolling on the positive g's

AERIAL ASSOCIATES PHOTOGRAPHY PHOTO (L39 ALBATROS)



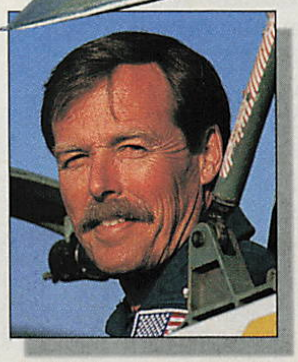
Polish TS-11 Iskra owned and flown by financial planning CEO Lynn High. Combat trainer is used for aerobatics and occasional trips.

and breaking things up with a zero gravity maneuver. Far from upsetting, Lutz's routine is poetry in flight. Total freedom in all dimensions. Obviously Lutz has done this sort of thing before. As a matter of fact, he tries to shred the skies at least twice a week just to keep sharp.

Lutz admits that he's trying to work up his nerve and skill for the tail slide—a tricky maneuver that he experienced at the hands of the Czech factory demo pilot. You go straight up and then slide straight down tail first. All the warning lights go on and the cockpit fills with smoke. It's real scary. We don't think that will stop Lutz from perfecting that move.

One notch below Bob Lutz's L39 is the Polish-built TS-11 Iskra. About 500 units were built in the 1960s and early '70s, and the Polish air force still has some 300 on active duty. The Iskra can fly as fast as the L39, but it lacks the air-conditioned comfort of the higher-priced Czech plane.

The red Iskra shown here also was imported by International Jets and subsequently purchased by Lynn High, CEO of the National Institute for Commercial Banking—a financial planning institution for the banking industry. High is a retired Air Force pilot with 21 years and 5000 flying hours. He spent a lot of time as a Russian analyst with the Air Force, so he was very familiar with Soviet bloc aircraft. Though High owned a couple of twin-engine Pipers, which he still has, he nevertheless hankered for a jet. The Iskra's reasonable $110,000 price tag was about the same as what he paid for his used Piper Aztec. (International Jets says prices on these birds start as low as $65,000.) The Iskra, a pure jet, burns about 150 gallons per hour, and High figures his total hourly cost, factoring in hangar rent, maintenance, etc., comes to $400.



Go ahead, Mach my day! Former Chief Astronaut Hoot Gibson (left) flies the Experimental Aircraft Association's supersonic MiG-21.

Tom Wood, a successful car dealer with a leasing and insurance business based in Indianapolis, did not fly while in the military, although he's always had an avid interest in aviation. Wood served as a combat engineer officer in the

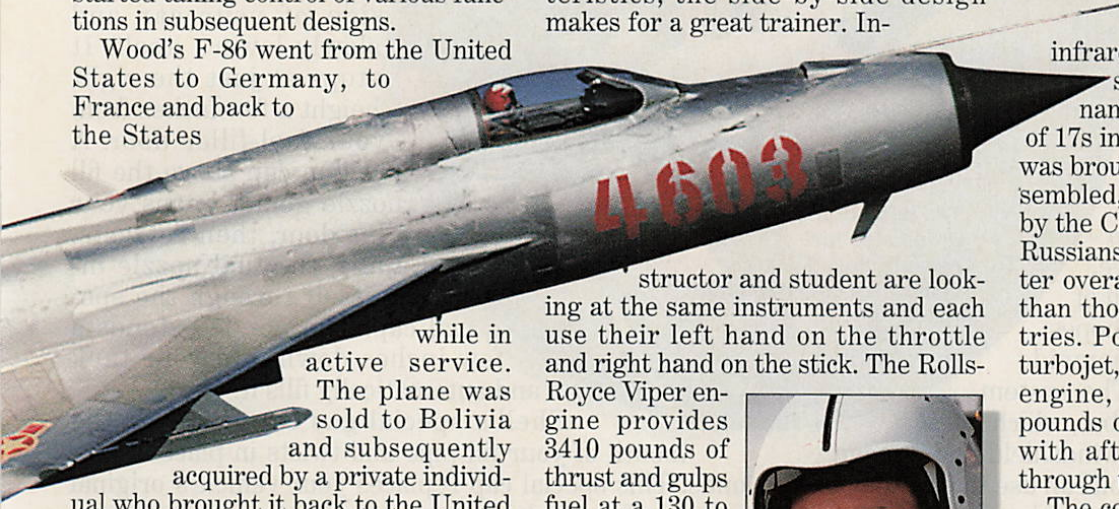
JIM KOEPNICK/EAA PHOTOS (HOOT GIBSON, TS-11 ISKRA, MIG-21, MIG-17)
PM PHOTO BY RAY HAND (LYNN HIGH); PHIL HIGH/EAA PHOTOS (OPPOSITE, DOUG SCHULTZ)

Army, and when he got out, he hooked up with some Air Force buddies that were having fun flying military surplus planes. Right after the war, you could pick up a surplus Mustang for about $1500. But there still was that fuel cost problem—then at 25 cents per gallon.

At the time, Wood owned a Beech Bonanza, and he started acquiring a flock of warbirds manufactured by North American, including a T-6 trainer and P-51 Mustang. In 1989, he bought a North American F-86 Sabre Jet—the next step up. This machine, with its graceful lines and Korean War combat heritage, is considered by many pilots to be the last of the great single-seat fighters in which the pilot was in total control. Electronics started taking control of various functions in subsequent designs.

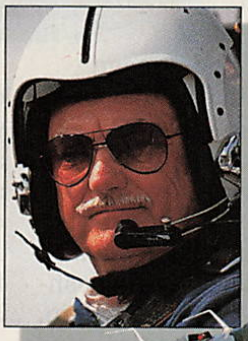
Doug Schultz is glad there are no heat-seeking Sidewinder missiles around when he kicks in the afterburner on his MiG-17.

Wood's F-86 went from the United States to Germany, to France and back to the States while in active service. The plane was sold to Bolivia and subsequently acquired by a private individual who brought it back to the United States, which is how Wood found out about it. Spending a couple of years restoring and flying this warbird, Wood has seen 0.9 Mach on the airspeed indicator, and the jet burns about 1500 to 5000 pounds of fuel per hour. Jet fuel weighs roughly 7 pounds per gallon. The F-86 is capable of going supersonic in a dive.



According to Wood, the F-86's flight characteristics are silky smooth, and he describes the power-assisted controls as effortless. This is a pure recreational toy for Wood, who takes it out for a spin, a loop and other aerobatics once or twice a week between April and October. His restoration efforts earned this warbird Best Jet honors at the Experimental Aircraft Association's 1993 Oshkosh air show.

One of the nicest of the flying combat jet trainers is the British Aerospace 167 Strikemaster. With no bad habits and predictable stall characteristics, the side-by-side design makes for a great trainer. Instructor and student are looking at the same instruments and each use their left hand on the throttle and right hand on the stick. The Rolls-Royce Viper engine provides 3410 pounds of thrust and gulps fuel at a 130 to 140 gallon-per-hour rate.



Ed Erickson gets plenty of stick time in Wally Fisk Jr.'s Strikemaster. This is one of the more docile warbirds.

Like all things British, this machine is a joy to operate. It's been described as a little sports car, pretty to behold and a pain to maintain. The Strikemaster here is owned by Wally Fisk Jr., who owns a number of businesses, including Amclyde—builder of the world's largest cranes. Fisk has acquired quite a collection of warbirds and has a staff to maintain them. This plane was one in a squadron of 13 that was decommissioned by the Republic of Singapore. Fisk arranged to buy 11 of them plus all the spare parts Singapore had accumulated—some 19,000 line items. While Fisk flies all his planes, most of the flying is done by Ed Erickson, his chief pilot.

Erickson, a retired military and airline pilot, doesn't officially work for Fisk, "so he can't really fire me," Erickson says. Erickson also instructs and checks out other pilots who want to fly in the Fisk Air Force.

Our mini MiG collection kicks off with Doug Schultz's Mikoyan Design Bureau MiG-17. Folks just love that exciting red-orange burner plume. So did our Sidewinder infrared heat-seeking missiles that shot down these MiGs in Vietnam. One of less than a handful of 17s in the United States, this plane was brought over from China, fully assembled, on the deck of a ship. Built by the Chinese under license from the Russians, the Chinese MiGs had better overall quality and better engines than those built in the satellite countries. Powered by the Klimov VK-1 turbojet, a derivative of a Rolls-Royce engine, the MiG-17 develops 5200 pounds of basic thrust—7500 pounds with afterburner—and can streak through the sky at 711 mph.

The cost of this warbird in 1991, including overhaul and minimal avionics, was $140,000. Today, the ones coming in from Poland are about $40,000 less. Schultz is a former Navy pilot who flew F-4 Phantoms in Vietnam off the carrier *Midway*. He flies his MiG as

(Please turn to page 117)

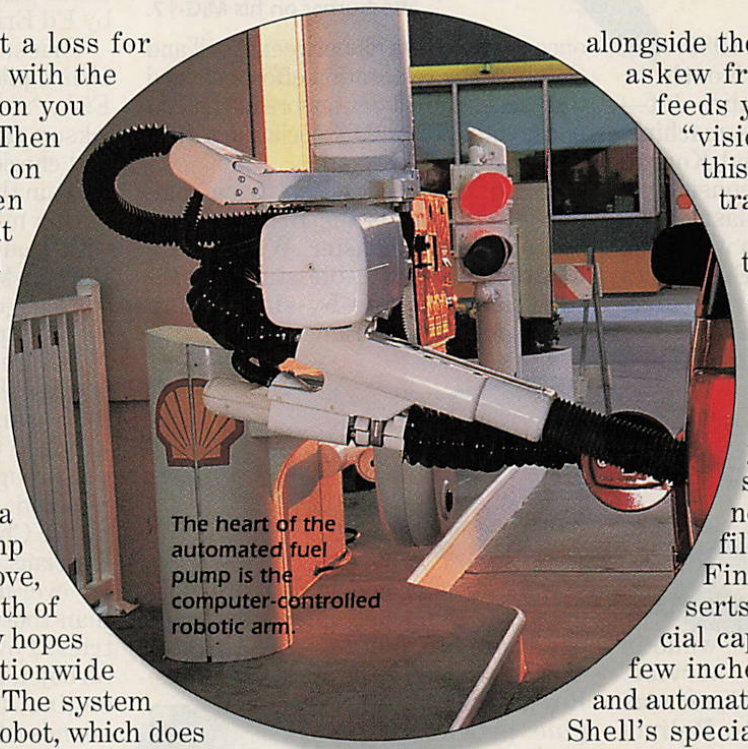
PHIL HIGH/EAA PHOTOS

FULL SERVICE WITHOUT A SMILE

At Shell's experimental automated gas station, a robot fills your tank.

BY MICHAEL LAMM, Contributing Editor; PM Photos by James A. Sugar

● If you find yourself at a loss for some polite conversation with the gas station attendant, soon you may not have to worry. Then again, if you've counted on him for directions when you're lost, you may be out of luck. That's because full automation is about to enter the filling station arena. Soon, there will be no one to say, "Fill 'er up," to anymore. In fact, you won't even have to get out of your car.



The heart of the automated fuel pump is the computer-controlled robotic arm.

Shell Oil already has a fully automated fuel pump up and running in Elk Grove, California, a few miles south of Sacramento. The company hopes to take the program nationwide over the next few years. The system centers around a fueling robot, which does everything but clean your windshield and engage in friendly banter. Before you can use the system, however, you must equip your car with a special transponder (like the ones used for automatic tollbooths) and a special gas cap, both of which are provided by Shell.

Here's how it works:

You pull into the station and an electronic sensor reads the transponder that you've placed on the dashboard, visor or wherever it can be read. As you pull in, the information from the transponder identifies your car's make and model. That's important, because it tells Shell's robot fueling system, called a Smart Pump, exactly where your fuel-filler door is located.

By now you've parked. A pay module moves to the driver's window. You swipe your payment card through the slot, choose the grade of gasoline you want, then hit the interior release for your car's fuel-filler door if your car is so equipped. Meanwhile, an overhead 3D camera validates the make and model of your car. It also reads exactly how you've parked—whether your vehicle is alongside the pump island or a little askew from it. The 3D camera feeds your car's position to a "vision" computer and adds this information to that of the transponder.

Based on these inputs, the Smart Pump's robot arm moves to the proper side of your car and slowly lowers itself. It stops at just the right height a few inches from your fuel-filler door. A suction cup above the fill nozzle gently opens your filler door, then retracts. Finally, the fuel nozzle inserts itself through the special cap. The nozzle extends a few inches down into your tank and automatically fills it.

Shell's special gas cap fits over the mouth of your fill pipe and twists in place in seconds. This special cap replaces your vehicle's original gas cap. The cap has a spring-loaded flap that provides an airtight seal. The fuel nozzle pushes the flap open and creates a tight seal. The cap also contains a series of vent slots so the fumes can be routed up through a secondary conduit and into a vapor canister. After it fills your tank, the nozzle retracts and the robot arm automatically swings up and out of harm's way.

And that's basically it. Shell adapted the concept after a Canadian company, International Submarine Engineering, originally developed the technology to fuel F-15 jet fighters while in flight.

Smart Pump's software stores and thus "knows" the fuel-filler locations of 99% of all cars sold in the United States since 1987. Shell will have to add about 200 more such computer "maps" each year as new models come out. (Still not in the system are a few sports cars and some low-volume imports.)

Smart Pumps, like their less intelligent brethren,

will dispense all three grades of gasoline. And automatic fill-ups typically take 2 minutes or so. Oh, yes, it's likely that you will pay more for this convenience than you would at self-serve pumps.

According to Chuck Shepherd, Shell's general manager of retail programs, the company plans to test several additional Smart Pumps under different climatic conditions through 1998. After that, says Shepherd, if the tests go well, you ought to start seeing Smart Pumps across the country.

By then, there may not be gas attendants to help you find your way around. But at least you won't have to make small talk about the weather forecast or which team had a good game the night before. **PM**

Shell's Smart Pump automatically fills your car's tank. All you need to do is pull up to the pump and swipe your credit card.

PM ILLUSTRATION BY JEFF MANGIAT

FORD F-SERIES

For 50 years, this vehicle has been the All-American Hauler.

BY JIM McCRAW, Contributing Editor

● Think about it. The best-selling vehicle in America, car or truck. Now think about this. The best-selling vehicle in America *for 16 years in a row*!

That's a phenomenal record that is absolutely unparalleled in the 111-year history of the motor vehicle industry. It is a record that has made other manufacturers drool with envy for years. No other vehicle has even come close. And it is a record that is ongoing and shows no sign of being curtailed at any time in the immediate future.

This incredible sales feat belongs not to a car but to a truck—Ford's F-Series pickup.

Happy birthday, Ford F-Series pickup.

This year marks the 50th anniversary of the first F-Series, and what a run it's been. No one could possibly predict what was to come when, on Jan. 16, 1948, Ford Motor Co. introduced its first all-new vehicle since the end of World War II. The F-Series was the first Ford pickup not based on a sedan, the first pickup truck designed from the ground up as a flexible, adaptable work vehicle for postwar America.

It wasn't Ford's first pickup truck chassis. That honor goes to the 1915 Model TT, built on a 124-in.-wheelbase version of the Model T chassis. It sold for a whopping $600. Ford didn't build its first complete pickup truck, the Model T runabout with a pickup body, until April 1925. It was a $280 bargain with a Model T front end, a cargo box, an adjustable tailgate, a set of four stake pockets in the bed for large-cargo haulers, and heavy-duty rear springs. As the Model A replaced the T in 1928, the Model AA pickup replaced the model TT, with new styling, better brakes, and the more reliable 200.5-cu.-in. 4-cylinder engine. When the Ford passenger car got the optional flat-head V8 in 1932, so did the pickup truck.

Enter the F

The first F-Series in 1948 came in eight weight ratings from F-1 through F-8, using a 95-hp 226-cu.-in. inline 6-cylinder engine with high-swirl combustion chambers, new intake and exhaust manifolds, and a new ex-

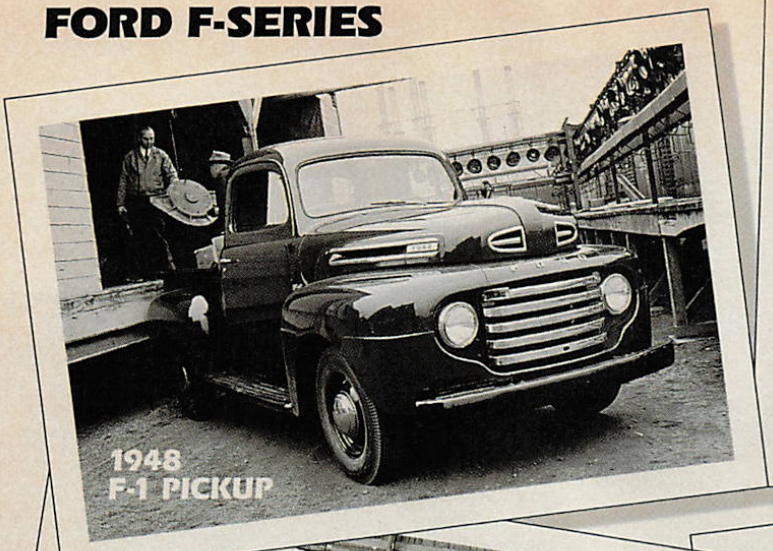
Fifty years and 26 million trucks separate the original 1948 F-1 and today's standard-bearer, the F-150.

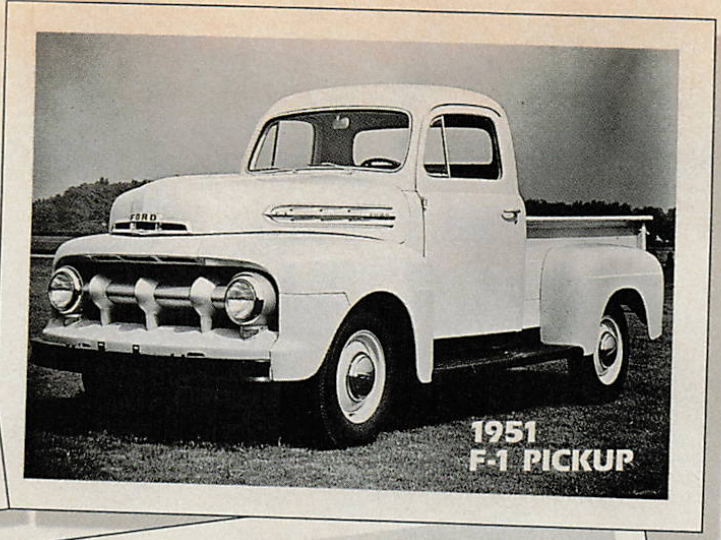
ternal oil pump assembly. As an option, buyers could choose the new 100-hp high-compression 239-cu.-in. flat-head V8. The big F-8 model had a gross vehicle weight rating of 21,500 pounds and was the biggest truck Ford had ever built.

But the volume model was the ½-ton F-1. It was vastly different from the prewar pickups, with a horizontal bar grille, recessed headlamps, a radical one-piece windshield, and side vent windows instead of one-piece side windows. The spare tire was moved to a new out-of-the-way location underneath the load floor to make the truck look cleaner and sleeker. This was the jet age, after all.

Ford sold almost 290,000 of those first F-Series trucks in 1948, more trucks than it had sold in any model year since 1929. Between '48 and '52, the F-Series underwent its first evolution. There was a new front-end design for the '51 model, a much larger rear window glass and a new instrument panel. In 1952, the venerable flat-head Six and V8 engines were phased out in favor of new overhead-valve designs called the Y-block engine family.

Nineteen-fifty-three was a big year at Ford. It was the 50th anniversary of the company. And while the passenger cars were largely continuations of the '52 models, the F-Series got a complete remake, including a completely new body shell with a curved windshield, a new grille and a new instrument panel. The whole relationship between the cab, the low fenders and the sloping hood was different than on any previous Ford truck. Ford also changed the model nomenclature: F-1 became F-100, F-2 became F-250, etc. Today, the '53 F-





100 is considered a classic by collectors everywhere.

The F-Series continued to evolve during the last half of the '50s. The '56 model had a new 167-hp engine, an available 8-ft. pickup bed, new tubeless tires and a 12v electrical system. The '57 model introduced the concept of a pickup truck without any discernible rear fenders—the slab-sided Styleside model which is still in the Ford lineup today. The fendered models were called Flareside. In 1958, the V8's power was bumped up to 181 hp, and the front end was revised to include a mesh grille and Ford's first quad headlamp setup on a truck. Also, power steering was offered.

Driving all the wheels

In 1959, the F-Series underwent a character and capability change when the first factory-built 4-wheel-drive systems were offered. Up until then, the few 4wd conversions ordered were made for Ford by the Marmon-Herrington Co., but Ford took the business in-house permanently in 1959.

The soaring '60s saw several significant changes to the architecture of the by-then hot-selling F-Series. The nose of the '61 model got shorter, wheelbases got longer, and overall heights got lower as the truck became more like a car.

In 1965, Ford retooled the F-Series once again, this time with the legendary Twin I-Beam front suspension—two forged steel beams going across the chassis transversely one behind the other, with one end pivoted from the frame and the other holding a coil spring, the wheel, spindle and brake assemblies, located fore and aft by a radius arm. For companies that needed to carry large work crews and tools, Ford offered the first crew-cab 4-door pickup trucks in 1965.

Brand NEW for '48
FORD Bonus Built TRUCKS
BUILT STRONGER TO LAST LONGER
Star-spangled NEW! . . . Excitingly MODERN!
. . . Strikingly DIFFERENT!
SIX YEARS OF NEWNESS PACKED INTO ONE
NEW MILLION DOLLAR TRUCK CAB
OVER 139 CHASSIS-BODY COMBINATIONS!
LIFE INSURANCE EXPERTS PROVE . . . FORD TRUCKS LAST UP TO 19.6% LONGER!

Fifty years ago, Ford ran this ad for its new trucks and launched a sea change.

A 1973 redesign brought a longer wheelbase, new floor pans, doors, roof panels, new body shell, a new instrument panel and the first use of front disc brakes on a pickup (available on 2-wheel-drive models). The Styleside versions had new, one-piece inner and outer panels. The fuel tank was relocated from the cab to the rear of the frame. So successful was the 1973 model that it finished the year as No. 3 on the list of best-selling vehicles, behind Ford and Chevrolet passenger cars. By now, Ford had more than 40% of the pickup market.

More room inside

By 1974, more families were traveling together in pickup trucks and needed extra room for kids, dogs and gear. Enter the F-Series SuperCab, with a longer cab, an extra pair of side windows, an extra 44 cu. ft. of space and either a folding bench or a set of jump seats behind the front seats. Ford added the F-150 model in 1975, in both regular and SuperCab variants, and it grew so popular that by 1984 the old F-100 model was dropped.

In 1977, Ford replaced the 360- and 390-cu.-in. engines with new 351- and 400-cu.-in. V8s. By 1978, the 30th-anniversary year of the F-Series and the 75th-anniversary year of Ford itself, the F-Series accounted for a staggering 864,000

1965 F-100 PICKUP

1973 F-100 PICKUP

1974 F-100 SUPERCAB

sales and was the best-selling truck in America.

To start the new decade off right, Ford introduced another all-new more carlike F-Series for 1980, with the first hint of Ford's aerodynamic styling. There were plush interiors, a laid-back grille, a new instrument panel and more options than ever. For the popular F-150 4wd, Ford devised a new coil spring independent front suspension system, a variant of the Twin I-Beam design called Twin Traction Beam. A factory-installed 6.9-liter diesel engine was optional for the first time.

In 1982, the F-Series got its first-ever V6 engine, the 3.8-liter 90° V6 derived from the 5.0-liter V8, and the pickup became the best-selling vehicle of any kind in the country, starting its record run.

In 1987, the F-Series was redesigned once again with a more aerodynamic nose section, a new instrument panel and a new climate-control system. It was the first pickup ever to offer rear anti-lock brakes as standard equipment. Power steering was made standard across the board.

In the early '90s, the F-150 was the recipient of a minor facelift, and a driver's-side airbag was made standard. The F-150 Lightning, the Ford Special Vehicle Team's first high-performance pickup, was introduced. The Lightning had a 240-hp 340-ft.-lb. 351-cu.-in. V8 under the hood and special suspension components that made it possibly the best-handling pickup truck ever built. Nearly 12,000 of these hot-rod trucks were sold.

Present and future

But the real breakthrough came last year with the introduction of the all-new F-150 and F-250 light-duty models—rounded, aerodynamic truck designs with not a trace of the old truck left behind. A reengineered 4.2-liter V6 base engine was joined by the world's first single-overhead-cam V8 truck engines. The 4.6- and 5.4-liter powerplants, offering up to 235 horsepower, came with the new frame, body and suspension and standard dual airbags. The 1997 SuperCabs offered an industry first—a third door on the passenger side.

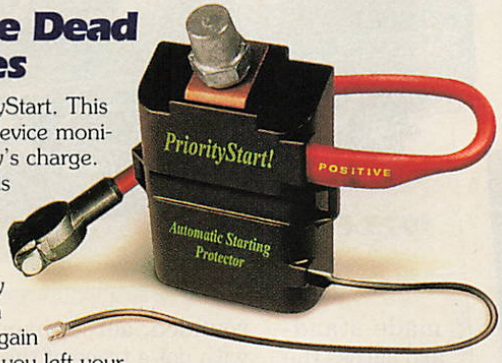
On Jan. 16, 1998, Ford celebrated 50 years of continuous F-Series production. Part of that celebration is a joint promotion with NASCAR—which happens to be celebrating 50 years of racing. The F-Series is now the official truck of NASCAR. And there will be a limited-production NASCAR special edition F-150 later this year. The F-Series is the most-produced vehicle of all time, at 26 million units and still counting. More than 8 million are still out there working and playing every day—a true American classic. **PM**

1998 F-150 XLT 4X4

Popular Mechanics Gear and Gadgets

Always on the lookout for new and useful items for our readers!

No More Dead Batteries



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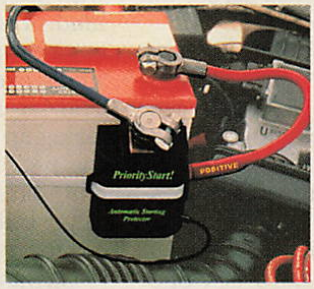

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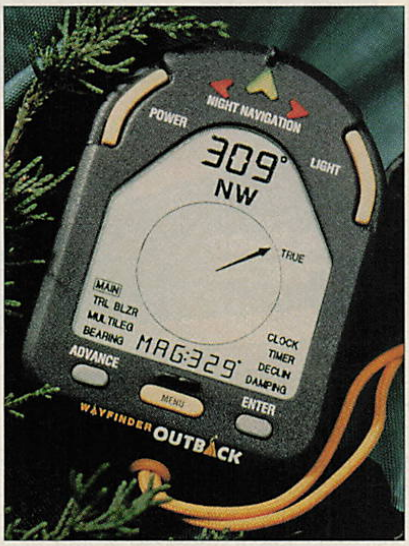

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CITY AT SEA

Nearly a mile long and 25 stories high, *Freedom* will be the largest vessel to ever sail the seven seas.

BY JIM WILSON, Science/Technology Editor
PM Illustrations by John Batchelor

● Norman L. Nixon loves to talk about the enormity of it all. "Walk in a straight line for about 12 minutes," he says. "If you don't dawdle, you'll cover slightly less than a mile. Now, make a right turn and walk beyond the length of two football fields. Duplicate these lines to make a rectangle, then look up to the height of a 25-story building. This is what *Freedom* will be." Listening to him talk about it, you begin to understand why Nixon doesn't refer to *Freedom Ship* as the world's largest vessel, but the

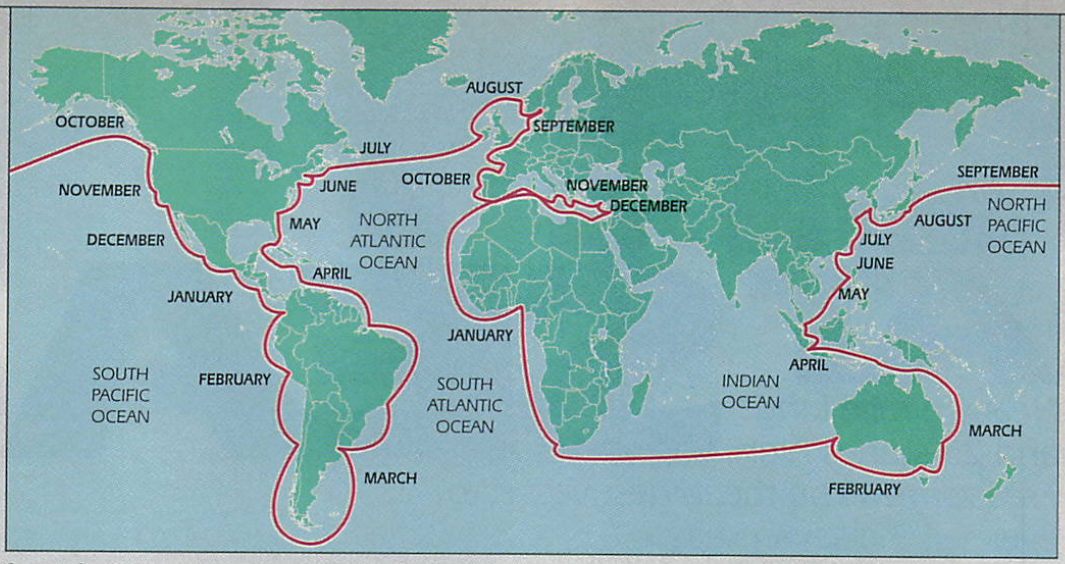
Freedom **will dwarf the *Queen Elizabeth II* and become a permanent home for 50,000 people.**

world's first floating city.

"*Freedom* will be large enough to bring on more than 50,000 residents, 15,000 employees, 20,000 day guests and still have four times as much roaming-around square footage per person as the most modern cruise liners," Nixon says during POPULAR MECHANICS' visit to see how his ambitious plan is progressing.

Taller than the highest buildings in most American cities and topped with a runway that can handle jets, *Freedom* may someday be the globe-trotting address for 17,000 homes and 4000 businesses. Its dimensions are so colossal that it will have to be assembled at sea. Once it's built, *Freedom* will circle the earth every two years, following the balmy breezes as it approaches the world's major ports (see map above). The wealthiest of her "citizens" will leave their 15-ft. by 80-ft. ocean-view apartments and board their private jets or yachts for jaunts to shore. Meanwhile, the 15,000 people who work aboard the ship will gear up for the next onrush of day visitors anxious to shop at its duty-free stores and guests checking in to vacation in its hotels and time-share condominiums.

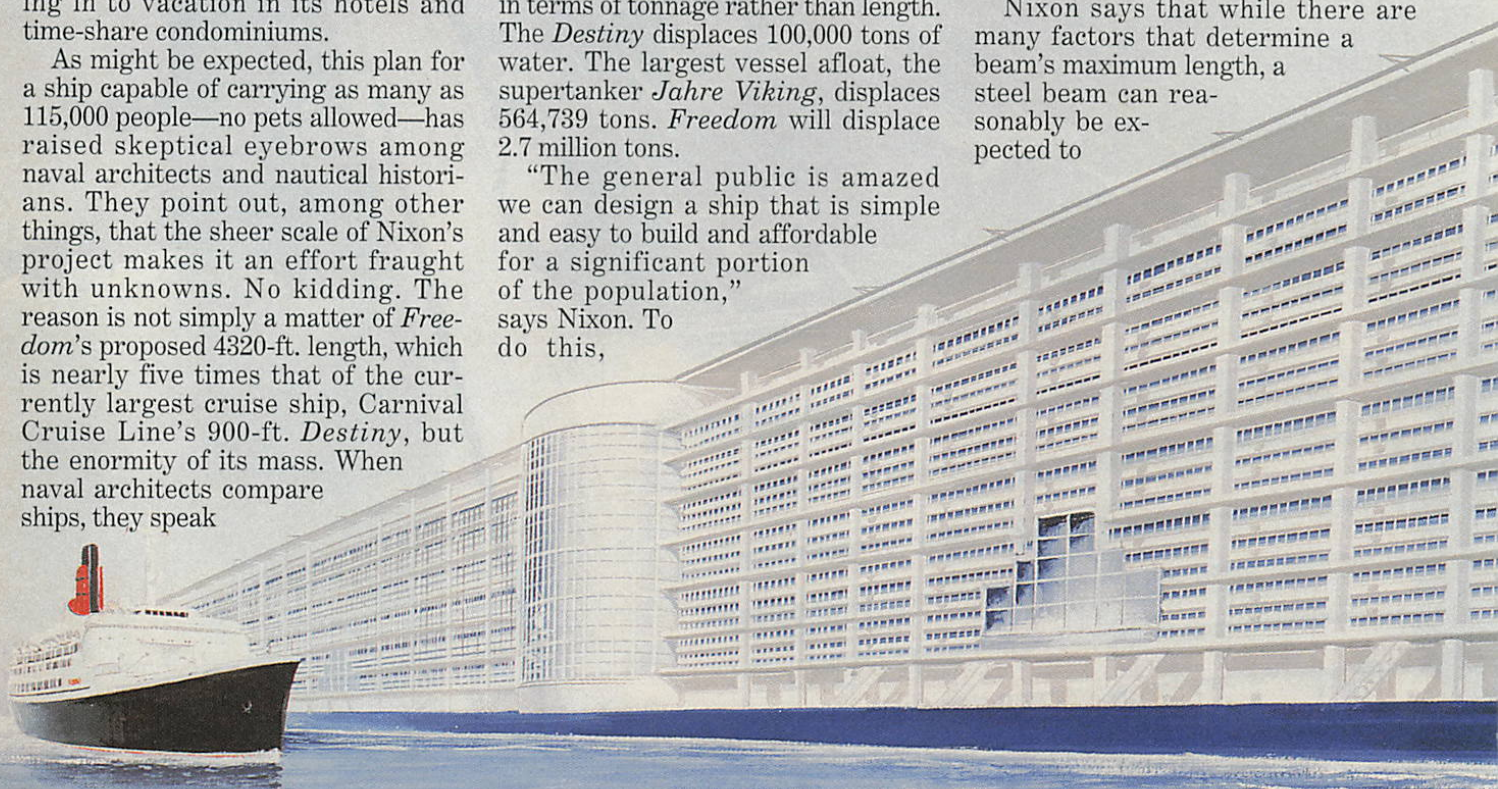
As might be expected, this plan for a ship capable of carrying as many as 115,000 people—no pets allowed—has raised skeptical eyebrows among naval architects and nautical historians. They point out, among other things, that the sheer scale of Nixon's project makes it an effort fraught with unknowns. No kidding. The reason is not simply a matter of *Freedom*'s proposed 4320-ft. length, which is nearly five times that of the currently largest cruise ship, Carnival Cruise Line's 900-ft. *Destiny*, but the enormity of its mass. When naval architects compare ships, they speak in terms of tonnage rather than length. The *Destiny* displaces 100,000 tons of water. The largest vessel afloat, the supertanker *Jahre Viking*, displaces 564,739 tons. *Freedom* will displace 2.7 million tons.



Nixon (left) expects *Freedom* to set sail two years after the start of construction. It will circle the globe by following a route that keeps its residents in perpetual sunshine. Many of the 600 who have signed on plan to operate businesses, such as duty-free shops, that will attract local tourists.

"The general public is amazed we can design a ship that is simple and easy to build and affordable for a significant portion of the population," says Nixon. To do this, Nixon is applying a lesson he first learned as an engineering student at the University of Arkansas in the early 1960s—keep it simple. And the technology behind *Freedom* is as basic as it gets. Airtight compartments keep it afloat. Linked together, they function as a steel beam.

Nixon says that while there are many factors that determine a beam's maximum length, a steel beam can reasonably be expected to



PM MAP BY GRAPHIC CHART & MAP, PM PHOTO BY SKIP GANDY

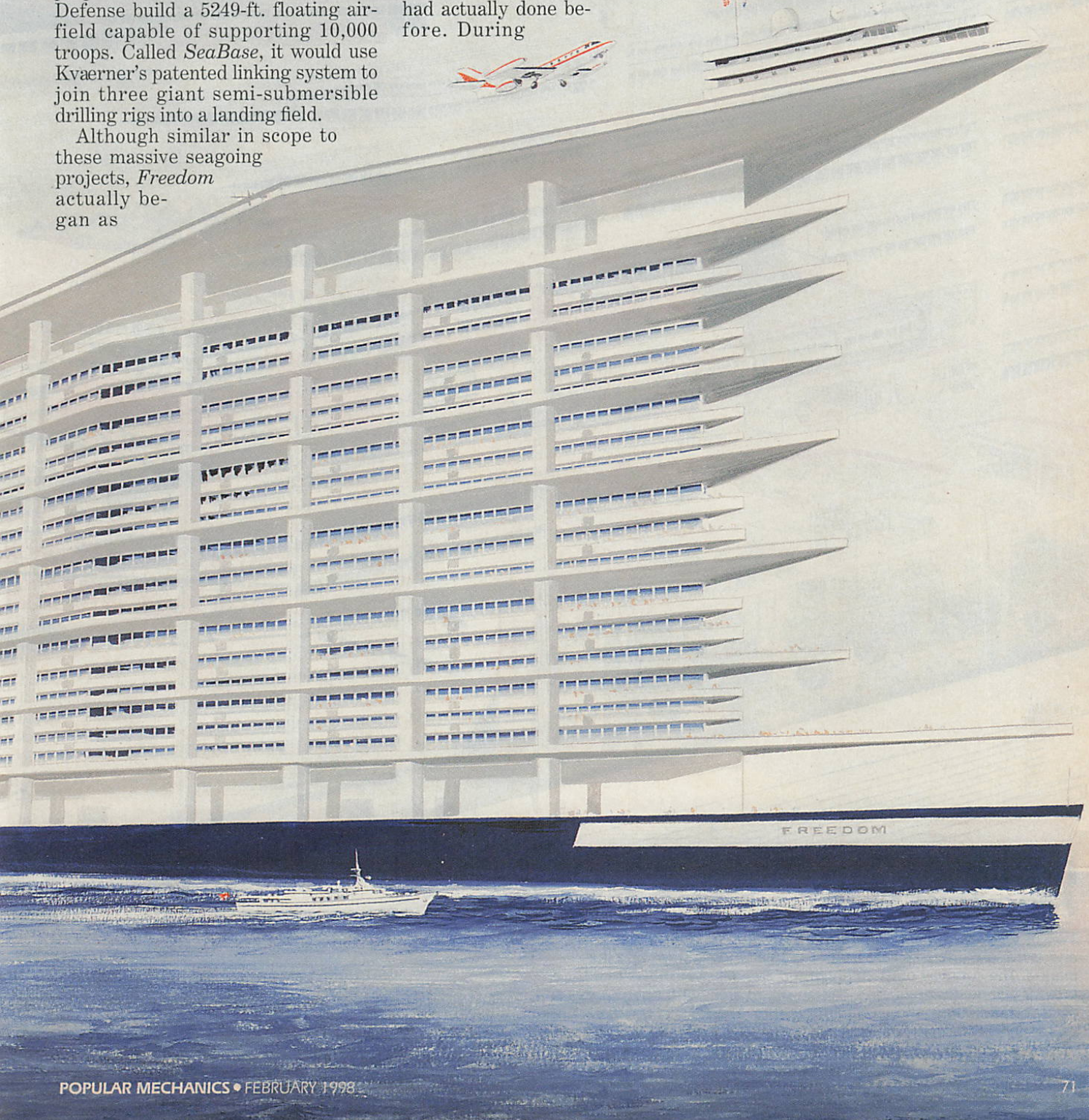
span a distance 15 times its height. "A ship with an effective depth of 80 ft. of hull [measured from keel to main deck] can theoretically span a maximum of 1200 ft.," Nixon says. "On *Freedom*, the effective beam runs 350 ft., from the bottom of the ship to the aircraft runway." The result is a 4320-ft.-long floating beam that draws 37 ft. of water as it rides atop waves, rather than plowing through them.

"We're not doing anything new," Nixon says. "We've taken technologies used in one area and applied them here." Indeed, Nixon says that during World War II the Navy used floating docks longer than *Freedom*. More recently, Kvaerner, the Norwegian ship and oil platform builder, proposed that the U.S. Department of Defense build a 5249-ft. floating airfield capable of supporting 10,000 troops. Called *SeaBase*, it would use Kvaerner's patented linking system to join three giant semi-submersible drilling rigs into a landing field.

Although similar in scope to these massive seagoing projects, *Freedom* actually began as an equally ambitious project on land. "We were on the verge of building an entirely new city on the 50-sq.-mile uninhabited island of East Caicos, south of the Bahamas. It was to serve as a modern Hong Kong," says Nixon. "Had the then chief minister not lost his reelection bid, we would probably be at work on the island today. In retrospect, the loss of this opportunity appears to have been the best thing that could have happened."

When a search of natural and manmade islands failed to turn up a suitable alternate location to East Caicos, one of *Freedom* city's original backers suggested building an island that could visit different countries each month. Strange as this suggestion seemed, it was something Nixon had actually done before. During the 1980s, he was part of a team of engineers who built a $1 billion modular ethylene plant in Japan and then towed it as more than 100 modules to Saudi Arabia, where it was reassembled. Encouraged by Nixon's hands-on experience in seagoing modular construction and the fact that he has licenses to practice structural, electrical, sanitary and civil engineering, his early supporters elected to follow his dream to sea. "And so," he says, "the *Freedom Ship* project was born."

Freedom promises to be as different from today's oceangoing vessels as the *Queen Elizabeth II* is from the *Mayflower*. Starting with the keel, *Freedom* doesn't have one. This backbone is missing because *Freedom* is constructed of 520 airtight steel cells.

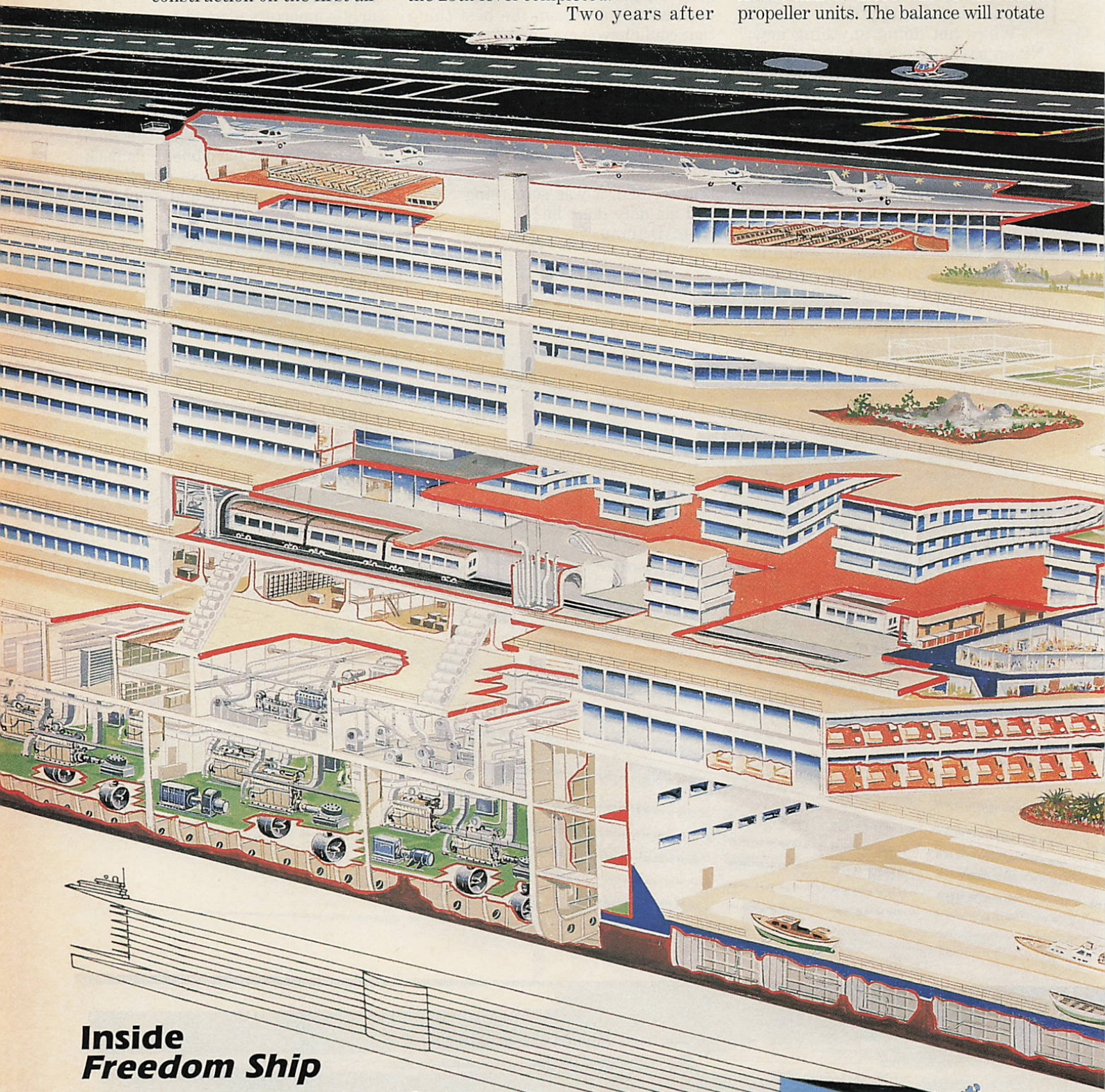


Each will measure 80 ft. tall. Depending upon its location, each will be 50 to 100 ft. wide and 50 to 120 ft. long. Assembled ashore on rails, they will be bolted together to form base units, each about 300 by 400 ft. These will then be floated out to sea and joined to form the completed base.

About 10 months after the start of construction on the first airtight cell, three base units will have been assembled at sea. At this point, the tempo of construction will increase. Meanwhile, on shore, four assembly lines will be dedicated to building airtight cells. At sea, work will begin on the 25-story superstructure. By the 17-month mark, the last base unit will be bolted in place and the 25th level completed.

Two years after the start of construction, 4000 of *Freedom*'s planned 21,000 units will be ready for occupancy. Her boilers will be fired up and she will set sail.

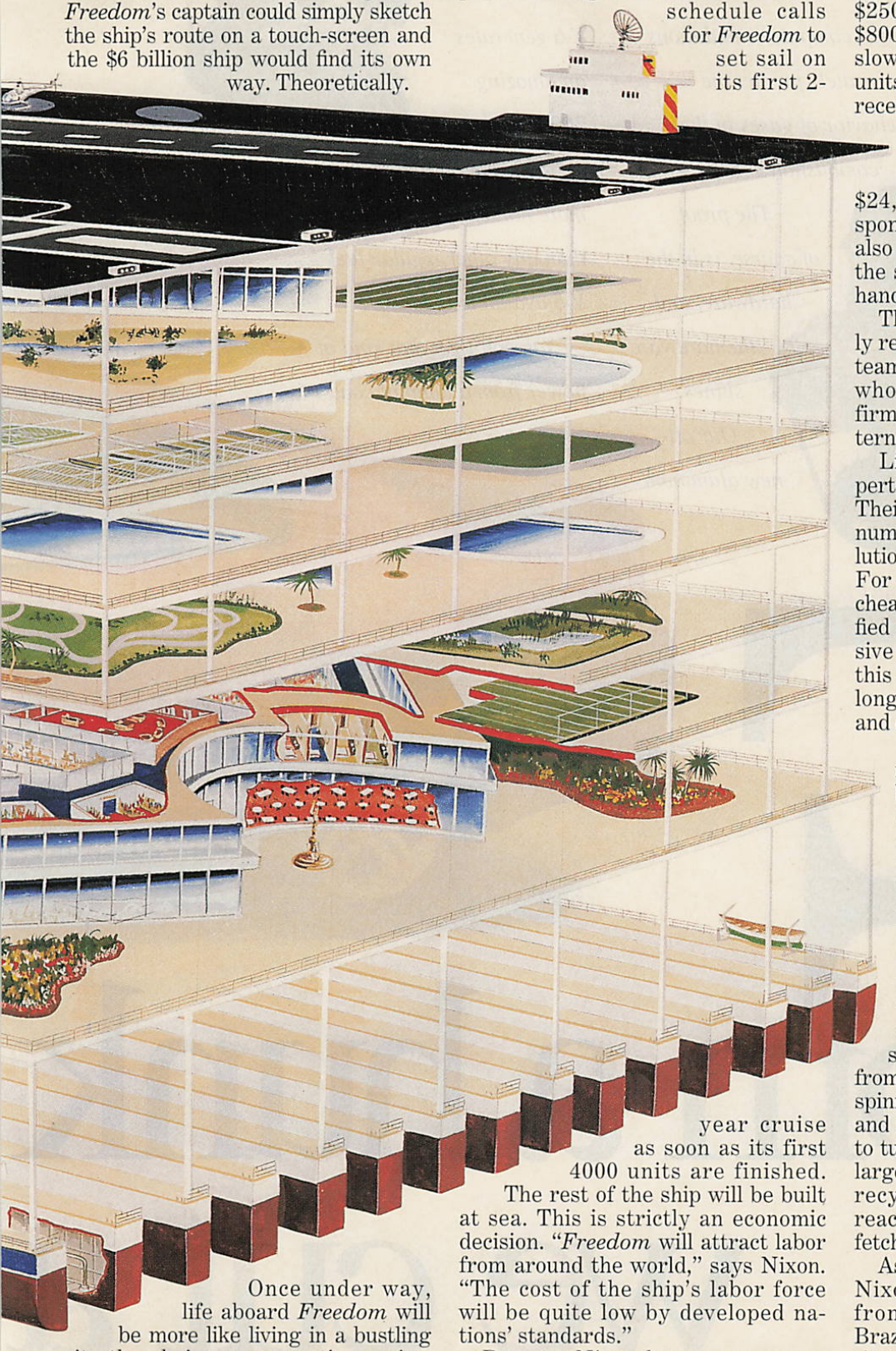
Well, not exactly. *Freedom* won't have the sort of boilers you find on traditional ships. She will be propelled by 3700-hp motorized units protruding through 100 of her watertight cells. About half of these will be shrouded propeller units. The balance will rotate



Inside *Freedom Ship*

Two of the most striking differences between *Freedom* and existing cruise ships are its jet-capable landing strips and the marina. The cutaway of the highlighted area (above) shows that the interior will be designed more like an urban area, with open spaces and transportation links, than a traditional ship. The view of the marina promises to be especially spectacular during heavy storms. Because *Freedom* will ride on top of the waves, residents will be able to look down at the troughs dozens of feet below.

360°, like those used on tugboats. At about $1 million each, these are among the world's most expensive marine powerplants. But, again, thinking like an engineer first and architect second, Nixon sees their cost as a bargain. This is because they can be linked to a central PC-type computer system. The helm thus becomes a joystick. And even this isn't necessary. Using GPS, *Freedom*'s captain could simply sketch the ship's route on a touch-screen and the $6 billion ship would find its own way. Theoretically.



Once under way, life aboard *Freedom* will be more like living in a bustling city than being on a vacation cruise. Because of its size, the ship will have its own railway system. Courtyards set about its decks will create interior park and recreation areas. Nixon has calculated that the resident population can support its own local economy, which means that residents will, in many cases, also be operating businesses at sea, in malls throughout the length of the ship.

As with a land-based city, these amenities and businesses will not appear overnight. The construction schedule calls for *Freedom* to set sail on its first 2-year cruise as soon as its first 4000 units are finished. The rest of the ship will be built at sea. This is strictly an economic decision. "*Freedom* will attract labor from around the world," says Nixon. "The cost of the ship's labor force will be quite low by developed nations' standards."

By now, Nixon has grown accustomed to criticism from the mainstream shipbuilding community. One of its first complaints was his inability to furnish blueprints of the completed ship. "Ships are designed by naval architects who then turn them over to structural engineers. We began with the structural engineering and will let the architects make it pretty," he says. In retrospect, this turned out to be a good strategy.

"We originally estimated the average condo sales price would be $250,000. But it is averaging over $800,000 per unit," Nixon says. To slow the sale of the most expensive units—those facing the ocean—Nixon recently jacked up the price by 20%. But, he says, they are still outselling the less expensive interior units, which cost as little as $24,000, by 10 to 1. Nixon has responded by adding another level. He also has added a second airstrip atop the ship and increased its capacity to handle 100,000-pound jets.

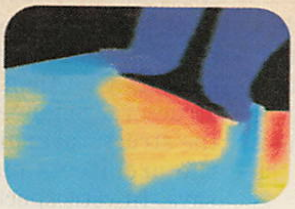
The "we" to which Nixon repeatedly refers as he describes *Freedom* is a team of 24 engineers and consultants who work with his Sarasota-based firm, Engineering Solutions, via Internet connections.

Like Nixon, many are technical experts from outside naval architecture. Their backgrounds have spurred on a number of decidedly non-nautical solutions to the problems of living at sea. For example, rather than burning the cheapest marine fuel, Nixon has specified engines that require more expensive diesel fuel. His rationale is that this cleaner-burning fuel will reduce long-term engine maintenance costs and create less pollution.

Freedom's proposed environmental systems are also a major break with tradition. For instance, sewage won't be flushed into the ocean. Instead, sanitary waste will be incinerated in electric toilets. "This eliminates the need for wastewater treatment," says Nixon. It is also the reason for a no-pets policy for residents and visitors. Graywater from washing will be recycled into drinking water. Recycling is cheaper than desalinating seawater. Waste heat from the engines will be recycled for spinning generators and heating space and hot water. Nixon even has a plan to turn trash into cash. *Freedom* is so large that it will be possible to store recyclable materials until the ship reaches a port where the scrap will fetch the highest price.

As this issue of PM went to press, Nixon said he was evaluating bids from shipyards in South Africa, Brazil, Poland and Mexico in preparation for beginning construction this year. If the project develops as planned, we'll be filing our next progress report on it from sea. **PM**

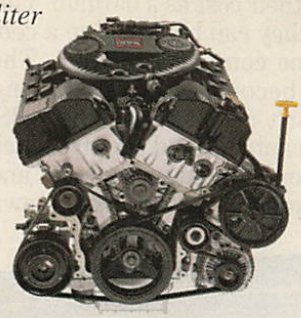
Power begets power. And our high-power digital engineering and testing capability has led to extraordinary gains in engine performance for the all-new Dodge Intrepid. Consider, for example, how much can be achieved when



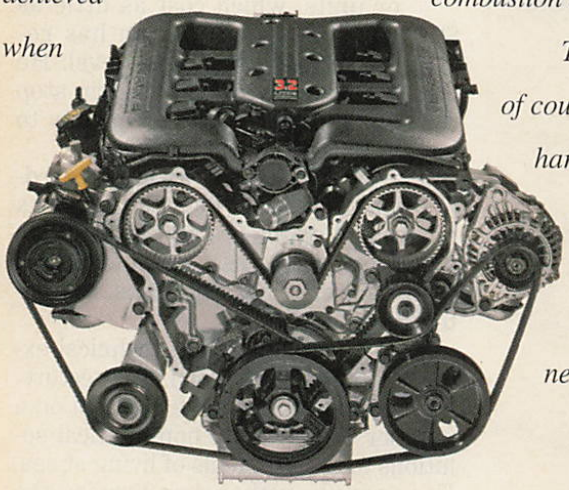
hundreds of intake manifold configurations can be tested instead of only two or three. Or how much can be learned when computer simulations accurately predict the behavior of gases in the combustion chamber.

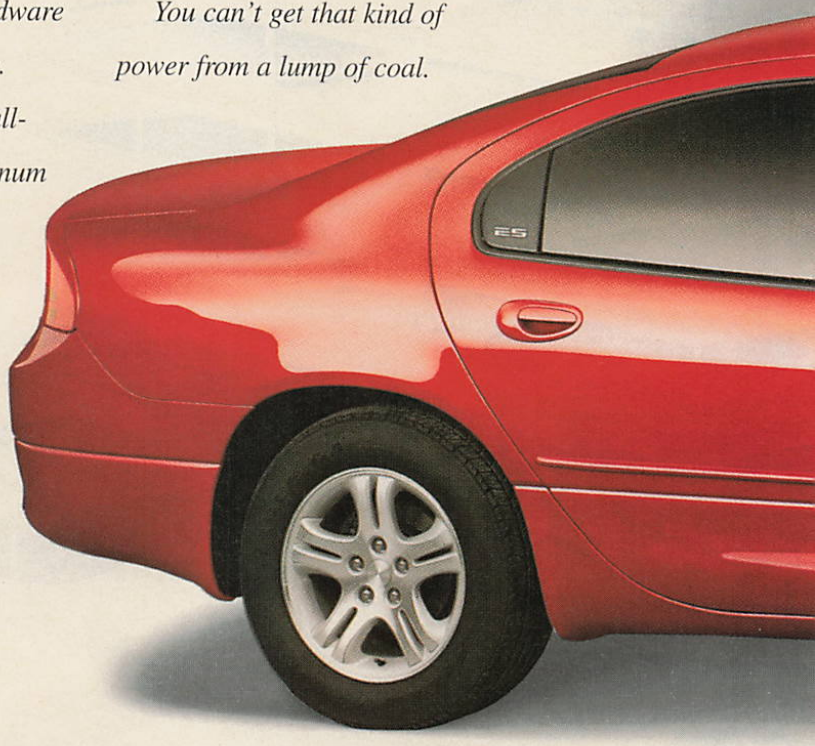
The proof, of course, is in the hardware, and the hardware shines.

Our all-new aluminum 3.2-liter 24-valve V-6 develops a stout 225 horsepower at 6300 rpm on regular fuel. Our all-new 2.7-liter 24-valve aluminum, base V-6 generates an amazing 200 horsepower at 5800 rpm on regular fuel – more horsepower per liter than any other regular-fuel V-6 available today.



You can't get that kind of power from a lump of coal.





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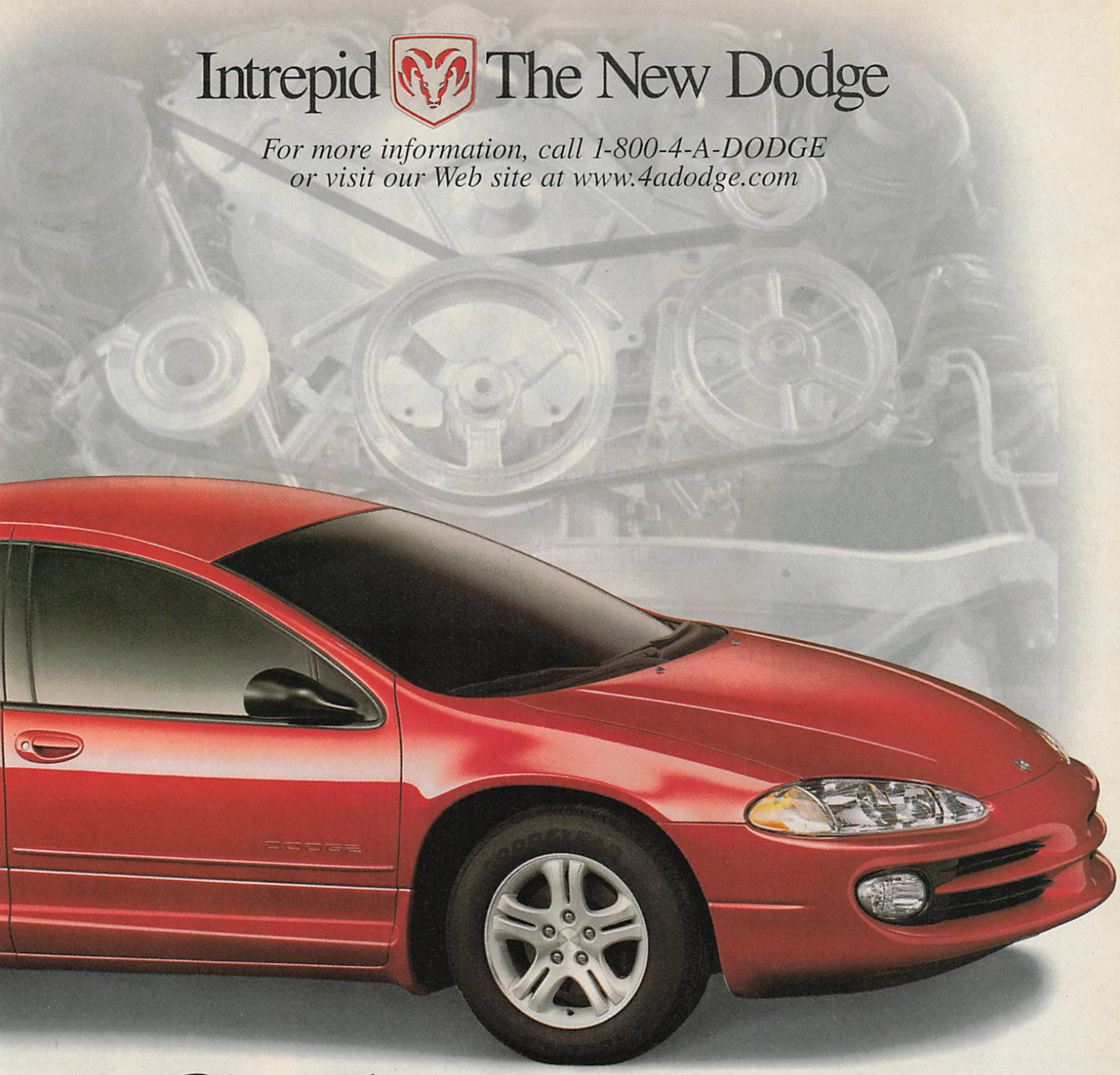


# of aluminum 3.2-liter gem.

Always use seat belts. Remember a backseat is the safest place for children.

THE PEOPLE PLACE

The Automotive Hall of Fame is a monument to the giants of the auto industry.

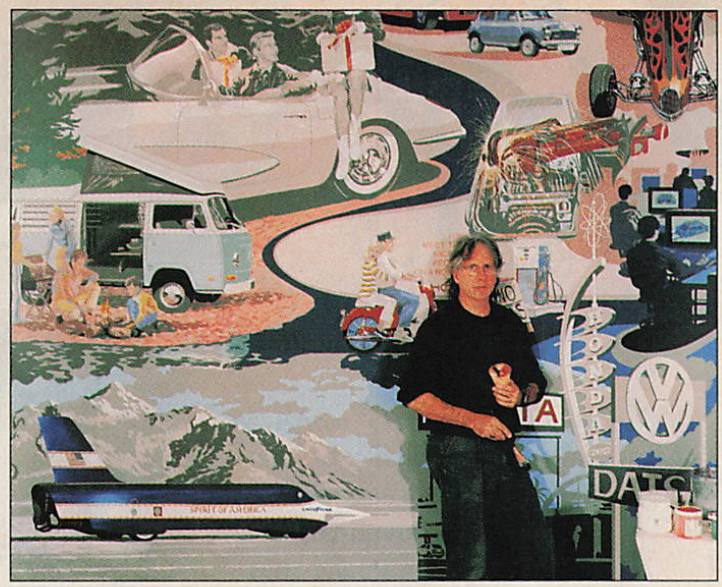
BY JIM DUNNE, Detroit Editor

● At last, all the giants of the automobile age have a home that honors their genius and their memory. Tucked in a corner of the Ford Motor Company's world headquarters complex in Dearborn, Michigan, is the sparkling new Automotive Hall of Fame—a striking monument to the achievements of history's automotive pioneers, inventors, builders and marketers. Now there is a permanent shrine honoring the world's outstanding auto personalities, a place where their deeds can be seen in a setting appropriate to their heritage.

Like bold auto designers, architects made no attempt to make the style of the new building match the Georgian decor of the nearby Henry Ford Museum nor the factory-like facade of the Ford Engine Development buildings next door. Instead, the exterior presents modern shapes, a soaring central atrium and bright hues on walls and rooftops.

But inside the Hall your eyes widen and your senses tingle. "We're not a car museum, but a people place," explains Gene McKinney, the Hall's president. "We show a 7-minute video, then let you walk through our recreations of factories, design studios, loading docks, early offices of our members, things like that."

A visitor can quickly see that the Hall exhibits auto-world titans in an everyday fashion, much as they would appear in their own time. A tour is not just a hands-clasped-behind-your-back stroll. Rather, working models let you get your hands on some of the

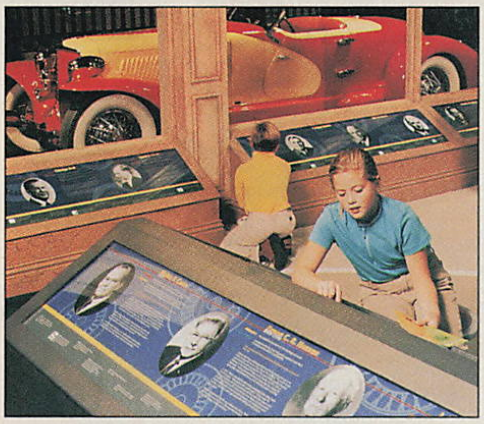


John Gable painted the Hall's 12-ft.-high, 65-ft.-long mural.

displays and perform many of the tasks yourself.

You set the pace on a self-directed tour that guides you to separate rooms dedicated to individual displays. In Ransom E. Olds' workshop and David Buick's research laboratory, you can match your skills with the inventors. A series of embossing stations lets you build your own idea of a car on a poster you can take home.

One of the more interesting displays focuses on automotive styling. At one stop, a large salon is set aside to display the works of Raymond Loewy, Virgil M. Exner Sr., William L. Mitchell, Harley J. Earl and their contemporaries and successors. Here, at least one outstanding car design of the past is displayed on a rotating time schedule. During PM's visit, the Hall was honoring a 1957 Plymouth Belvedere, a car that's sure to revive visitors' memories.



There are more than 150 Hall of Famers.

Laborers who toiled in the world's car factories are not forgotten. A special room is set aside for Walter P. Reuther. In it, a dining table in a recreated West Virginia home depicts where he gleaned his early ideas of labor dignity.

A time clock at another station honors the history of immigrants who worked the early factories in the United States. You'll encounter an "employment station" where you can answer want ads for factory work and test your luck at being hired.

"Get involved in your tour of the Hall." That's the constant message you can't help see and hear. For example, one of the most personal stops in the tour measures your personal aptitude traits. Another display invites you to take the place of Ralph Teetor, a blind inventor who is credited with the development of a number of patents, including cruise control. Teetor also founded Perfect Circle Piston Co. At his corner in the Hall you can test your blind acuity by using your hands to identify shapes that are placed out of sight.

Five career traits that typify Hall of Famers are spelled out so you can see how you measure up. You can check to see if you are an innovator, prime mover, visionary, problem solver or creative spirit.

A different Hall of Famer exemplifies each:

Harvey S. Firestone Sr. represents an innovator. He developed softer-riding rubber tires as replacements for old-fashioned carriage wheels. If you are an innovator, you are suited for a career in automotive manufacturing or finance, where you can improve on established routines.

John W. Anderson fits the description of a problem solver. One rainy night he couldn't find a replacement wiper for his windshield. He fixed that problem by inventing a wiper that would fit just about every car. According to the Hall's brochure, if you're a problem solver you are suited to areas like purchasing and supplies, robotic assembly, product design or cost analysis, among others.

Karl Benz and Ransom Olds are dubbed visionaries. Frequent changes in model lines call for planning that relies heavily on visionaries. So, just about any part of the vehicle-building process, including manufacturing design, powertrain research and chemical sciences, calls for that key trait.

Styling salon features outstanding designs.

Edward V. Rickenbacker symbolizes the creative spirit. If you have the spark of creativity, you would do well in automotive professions like product design, advertising and marketing. Eddie Rickenbacker, of course, was a famous race driver, WWI pilot hero and the owner of a speedway. His exploits form one cornerstone of creative thinking, always a vital asset.

Gottlieb Daimler is cited as a prime mover, someone who began new industries that today involve one in every six Americans. He started "a modern technological revolution," according to a 1889 newspaper account. More than 150 leaders from all disciplines within the industry have been inducted into the Automotive Hall of Fame since its inception in 1939, and new members are added each year. PM

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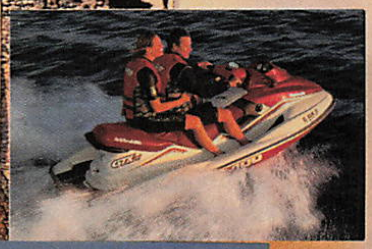

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Boating '98

BEAUTY AND THE BEASTS

This year, boats are all about refinement and engines are all about innovation.

BY JIM GORANT, Outdoors Editor

FORMULA 330 SUN SPORT

TOYOTA 300-HP V8

● It's an odd year in the boating world. On one hand, most of the attention-grabbing new boats hitting the water simply don't represent groundbreaking ideas. Instead, they incorporate noteworthy tweaks, improvements and adjustments to already existing designs.

On the other hand, engine manufacturers, pushed by the first phase-in period of the federal Environmental Protection Agency's new off-road emissions standard, continue to bring innovative new engine technologies to the marine power market on what seems like a daily basis. What's more, engine improvements abound in not only the outboard category but among inboards and sterndrives as well.

Boating '98

BAYLINER 2050 CAPRI LS

One huge development that turned heads in both the boat and engine categories was Toyota's announcement that it was entering the marine market through a new division called Toyota Marine Sports. The company's initial offerings include two direct-drive ski boats and a marinized version of the same engine that powers both the Lexus GS 400 and LS 400 luxury-performance automobiles.

The boats, which will be designed and built in the United States, won't be available until mid-summer '98. But months ago, Toyota was already displaying the 4.0-liter 1UZ engine. Since the engine is only available as a package with the boats, no one knows exactly how it performs just yet. But have you driven a '98 GS 400 lately? If the marinized version of this engine performs as well, the boats should be screamers.

Sport Boats

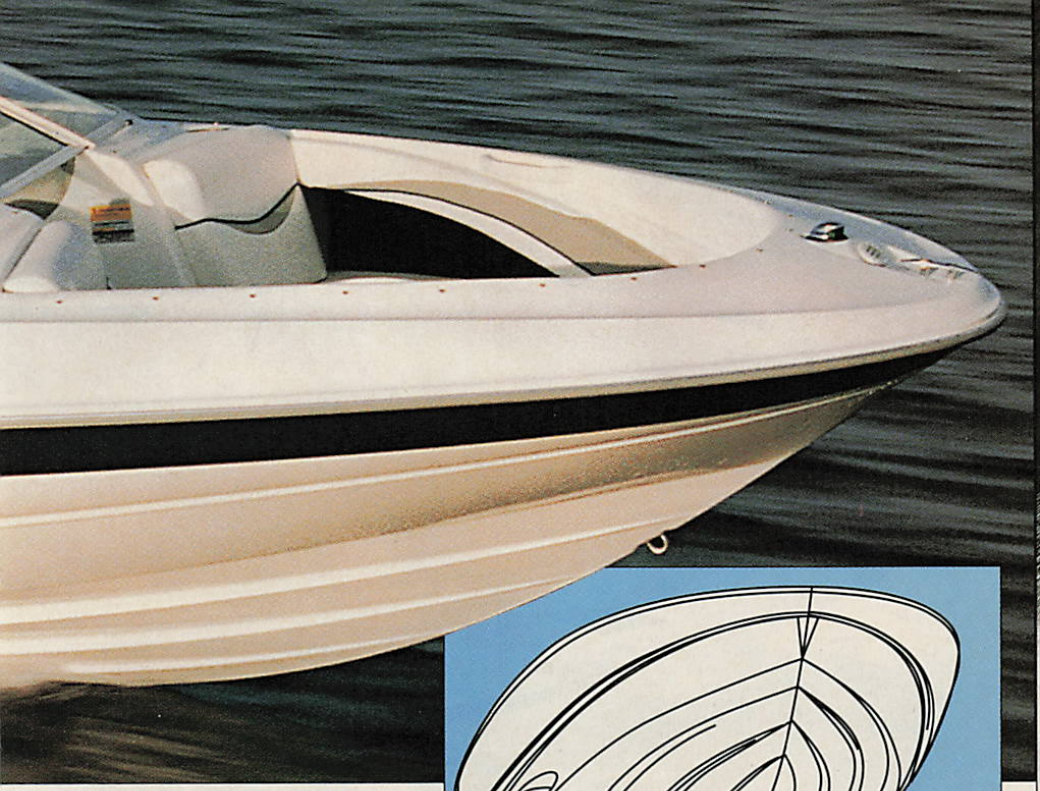
True to '98 form, the Formula 330 Sun Sport deck layout is a refinement of a proven design. A cockpit galley sits across from a U-shaped lounge with a table that makes a comfortable dining area. After lunch, you can lower the table, add some filler cushions and the entire space becomes a large sunpad. Belowdecks there's a stand-up head and a V-lounge that converts to a bunk. With twin MerCruiser 7.4-liter MPI Bravo Threes, it'll run about 55 mph. The $114,000 price tag may seem steep. But remember, this package includes topside recreation, overnight accommodations and speed.

Regal is taking this idea of an adaptable configuration one step further. For $35,000, the new 2500 LSR gives you three boats in one. At first glance, it looks like a stylish bowrider with bow seats and a standard cockpit arrangement. There's even a marine head and a small berth tucked under the helm console. But remove the side windows, add bow and cockpit tables and convert the aft section to a sunpad with filler cushions, and the 2500 becomes a deck boat. It even has a swim platform and fore and aft boarding ladders. If you want to go fishing, leave the side windows out and remove all the cockpit seating as well. Now you have unencumbered access to the coamings. The bow table and engine box become casting platforms, and an optional fishing package includes tackle box, raw-water washdown, baitwell and rod holders.

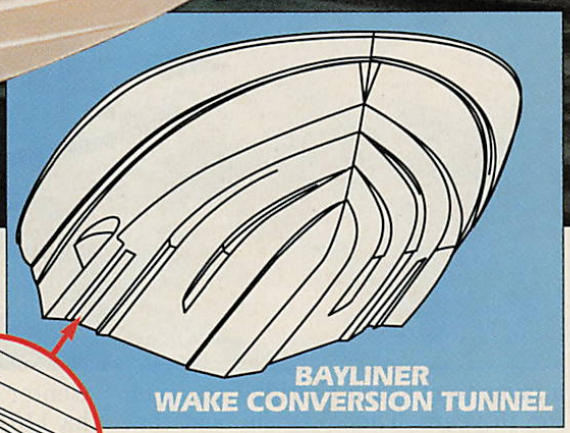
REGAL 2500 LSR

REGAL 2500 LSR

The new Regal also includes the company's FasTrac hull, which uses



SEA RAY
210 SUNDECK



BAYLINER
WAKE CONVERSION TUNNEL

hull steps and strakes to improve power, speed, efficiency and handling. This year Bayliner counters with its own advanced hull design that has many of the same benefits.

The Bayliner 2050 Capri LS introduces Bayliner's advanced planing system (APS), which has several components. The first is Sequential Lift, a variable deadrise system that concentrates water toward the stern to get the boat on plane faster and reduce bow rise during acceleration. Then there's the Vectored Strake System, which accelerates the water flow under the boat to reduce drag and increase tracking. The Wake Conversion Tunnels, which are recessed channels just inside the chines, limit transverse flow—similar to an airplane's vertical winglets—and further reduce drag.

The Capri also has a single-piece wraparound windshield that eliminates the conventional A-pillar for an uninterrupted view in all directions. And it all comes at the value-sensitive prices Bayliner is known for. The 2050 Capri LS costs $13,595 with a trailer and a 3.0-liter MerCruiser, while the same boat with a 5.0-liter engine jumps to only $16,495.

In contrast, Sea Ray is using a proven hull to refine the deck boat idea. The company's new 210 Sundeck is a classic deep-V hull with 21° of deadrise. Even on a boat this small, the deep-V does what made it famous—it allows you to maintain speed in rough water. Above the water the 210 has the wide, open layout that has made deck boats so popular. Full wraparound bow seats and an optional aft-facing chaise lounge in the cockpit allow you to relax in comfort once you get where you're going. Now, for $25,679 you can get a deck boat with the performance and handling you're used to in a runabout.

The deep-V is also making a comeback in the form of the rejuvenated Glastron/Carlson line. These boats with 24° deadrise hulls spark vivid memories of the '60s, '70s and '80s, when they dominated the waterways. The line was discontinued in 1990, but it's being reintroduced with three new models: the CSX 17, CSX 21 and CSX 23. All of them are sterndrive boats with Glastron's notable polyflake gelcoat graphics in stylish patterns.

GLASTRON/CARLSON
CSX 21 BOWRIDER

Boating '98

Billed as the boats that are available and affordable to the average Joe, the Glastron/Carlsons still have their old appeal. The new 21 with a 5.7-liter MerCruiser sells for $31,540.

Fishing Boats

But if speed is really what you're after, check out the Cobra Predator 3000 catamaran. The hull is based on Cobra's world-champion offshore racing boat and has been race tested up to 120 mph. With a pair of stock Suzuki 225 EFI outboards, it costs $93,995 and runs 83 mph at the top end with a 60-mph cruise speed. Since both catamarans and EFI outboards are noted for their efficiency, it's not surprising that the Predator 3000 is economical to run. At that 60-mph cruise speed, it burns only 26.6 gph, giving it a 390-mile range.

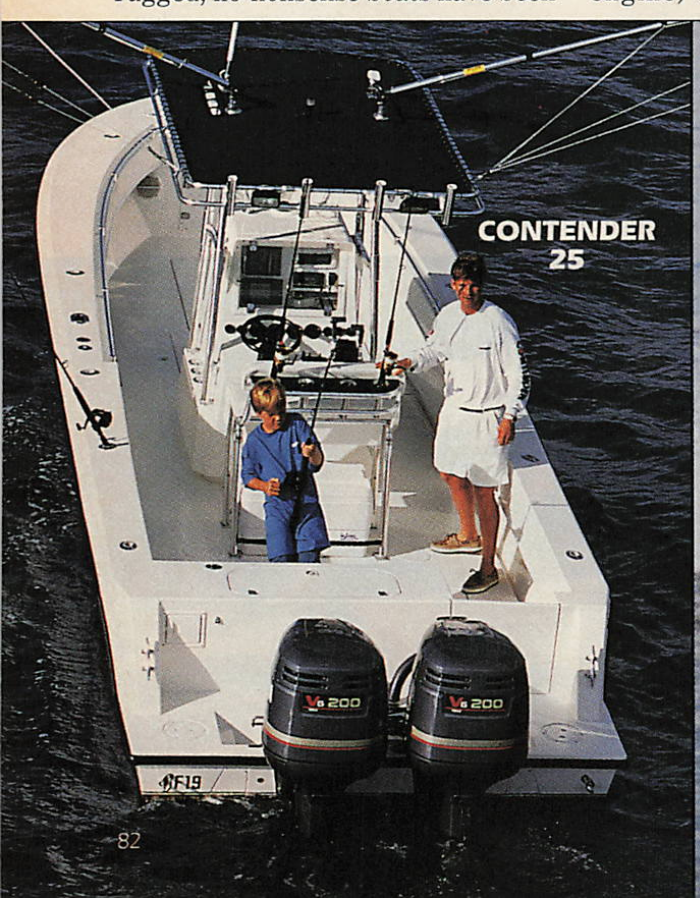
But the Predator is more than just another go-fast. It's a fully equipped fishing boat. Targeted at tournament kingfish anglers who have to run great distances to chase down their prey and still make it home in time for weigh-in, the boat has a full complement of fishing features that would make any fisherman happy. These include a 40-gal. livewell, bait-rigging station, 245-quart fish box, two rod lockers, raw-water washdown and enough rod holders to start your own tackle store.

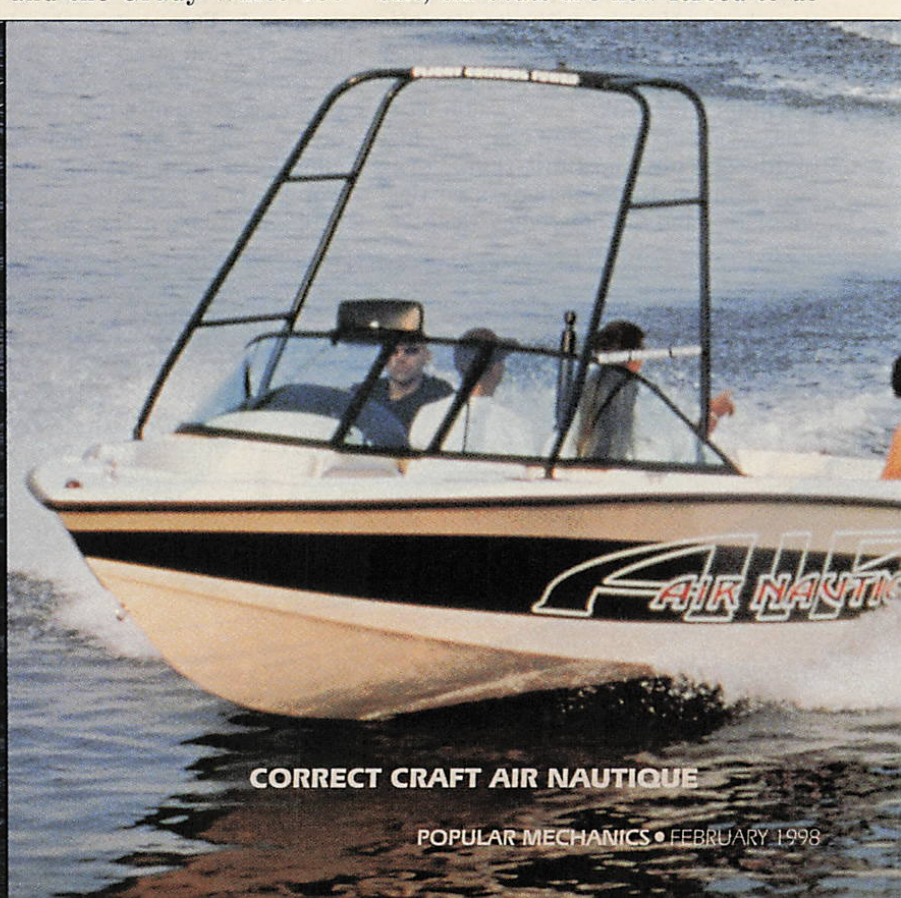
If you're a fisherman, there are other options for '98. One of the more prominent is the new Contender 25 Center Console. Although this Miami-based company isn't well-known nationally, Contender's rugged, no-nonsense boats have been a favorite of south Florida fishermen for 15 years. The 25 is the boat that started it all, and now it's been completely redesigned to reflect what the company has learned over the last decade and a half. For $39,215 (without power), it will open waters that other boats shy away from.

Other fishing boats of note include a few entries from illustrious names in the field. There's the new Boston Whaler 26 Outrage ($34,981, without engine) and the Grady White 180 Center Console ($24,810 with Yamaha 115). Pursuit has chimed in with two new 22-footers, the sterndrive-powered 2260 Denali and outboard-powered 2270 Kodiak (both $39,995). It's also coming out with a yet-to-be-seen 30-ft. express boat sometime this spring.

Water Toys

Wakeboarding is one of the fastest-growing sports on the water. As a result, ski boats are now forced to do





CORRECT CRAFT AIR NAUTIQUE

COBRA PREDATOR 3000

double duty—delivering the soft, flat wake skiers want and the large, sloping wake wakeboarders want.

The most exciting new boat in that respect is probably the Correct Craft Sport Nautique. It features a wrap-around stern with a sun deck and 14-cu.-ft. trunk. It also has a Launch Control System, which is two 25-gal. ballast tanks in the stern. When the tanks are full, it adds 400 pounds to the back of the boat, creating a larger wake for wakeboarders to launch off. You fill the tanks just by opening two valves while under way and empty them by letting the boat sit still.

Small steps along the chines keep the wake flat while the ballast tanks are empty and give the wake the perfect slope, length, hardness and lip when they're full. The Air Nautique option adds a flashy graphics package and a 43-in. tow pylon. Another option is the Flight Control Tower, which puts the pulling point 80 in. above the water for really great launches. When it's not in use, the tower folds onto the foredeck or lifts off completely.

While wakeboarding is one exciting outlet on the water, for several years now mini jet boats have provided another. Most of the developments this year were rehashings of already existing boats. The most significant of these is Yamaha's Exciter 270 ($16,999 with trailer), which saddles up two 135-hp 3-cylinder engines in one 16-ft. 7-in. boat. The power package gives the Exciter 270 hp, the most of any jet boat avail-

YAMAHA
EXCITER 270

SEA DOO GTX RFI

able, and a 60-mph top speed.

Another interesting jet boat is the Regal 1700 XR2. For $14,870, this boat pairs a 17-ft. LSR hull with Mercury's 175-hp Sportjet engine. What sets it apart, though, is the interior. Instead of the padded bathtub arrangement of other small jet boats, the 1700 XR2 looks like a regular sport boat. It's got full-height gunwales, a standard helm and a fully upholstered interior with surround seating. We smell a trend.

Another trend emerged this year for personal watercraft (PWC). For $7799, the Sea Doo GTX RFI features Rotax Fuel Injection (RFI) and the new D-Sea-Bel noise reduction system. This is the first instance of advanced outboard technology trickling down to PWCs. As the EPA standards begin to affect PWCs as well, more are sure to follow.

RFI uses a low-pressure nozzle that indirectly injects fuel into the combustion chamber, which improves efficiency, reduces hydrocarbon emissions and decreases engine vibration. The D-Sea-Bel system uses several techniques to reduce noise. Intake and exhaust ports are wrapped with acoustic insulation to absorb some sound. The pump is mounted on a rubber housing to reduce high-frequency noise caused by vibration. Also, a Hemholtz Resonator uses pipes of varying length to cancel out certain-frequency sound waves. Overall, the 1998 GTX RFI's sound pressure level measures a full 50% lower than last year's model.

While the GTX RFI is the jewel, Sea Doo also introduces a high-performance 3-seater, the GTX Limited ($7799). Yamaha adds a 3-seat cruiser as well, the XL1200 ($7599) and the high-performance GP800 ($6799). Kawasaki gets in on the action with the high-performance 1100 Zxi ($7399) and the Xi Sport ($4999). But the biggest eye-opener out of Kawasaki is the redesign of the industry-defining stand-up Jet Ski SXi Pro ($5499).

This year marks the original Jet Ski's 25th anniversary. For the occasion, Kawasaki changed the hull so it's easier for beginners to ride, yet it still offers a challenge to seasoned veterans. The new boat's bow rises at a sharper angle and sponsons run along the hull/deck line to aid stability and cornering. The 743cc engine cranks out 75 hp, so the SXi Pro is still as exhilarating as ever to ride.

Tigershark has been perhaps the most active PWC builder, bringing out five new models this year. Its TS 770 offers some pretty impressive numbers. At 111 in., the long 2-seater stretches across the wave tops for a smooth ride, while a new 768cc 80-hp engine provides plenty of push. And perhaps the best part of all is the price—$5499 takes the tiger.

KAWASAKI JET SKI SXi PRO

Engines

The Toyota/Lexus 1UZ engine mentioned earlier is a huge step in the development of marine power. It's the only double-overhead-cam engine in the marine field, and the innovations don't stop there. The 90° V8 produces 300 hp at 6000 rpm and 310 ft.-lb. of torque at 4400 rpm. There's multiport fuel injection and a 32-valve belt-driven valvetrain features variable

timing. And since the block and cylinder heads are aluminum alloy, the complete engine weighs in at just a little more than 628 pounds.

But Toyota's Lexus engine is by no means the only major development in power for 1998. Several other engines borrow parts and technologies from the automotive world.

One example is the MerCruiser 454 Mag MPI Horizon. The Horizon uses upgraded components to reduce maintenance and increase efficiency. In fact, MerCruiser guarantees the Horizon to be maintenance-free for three years (except for oil and filter changes). Some of the items that make that possible include high-capacity spark plug wires, stainless steel and brass fasteners, ceramic-coated manifolds and elbows, a single serpentine accessory drivebelt, a freshwater flush system and platinum-tipped spark plugs.

But more than just maintenance-free, the Horizon is a high-powered performer, producing a spine-compressing 380 hp at the propshaft. The 7.4-liter engine utilizes a computer-controlled multiport cross-ram injection system with a dual 60mm throttle body. A unique roller cam helps provide more torque at the low end, quick throttle response throughout the midrange and extra punch at the top.

Speaking of extra punch, Yamaha's new VMAX 3.1-liter outboard is available with a 20-in. shaft, so it's now the largest-displacement engine a bass boater can buy. The 225-hp engine features Yamaha's Ox66 fuel injection system on a 76° loop-charged block. Electric trim pivots the engine from -4° to +16° for an excellent hole shot and great top end.

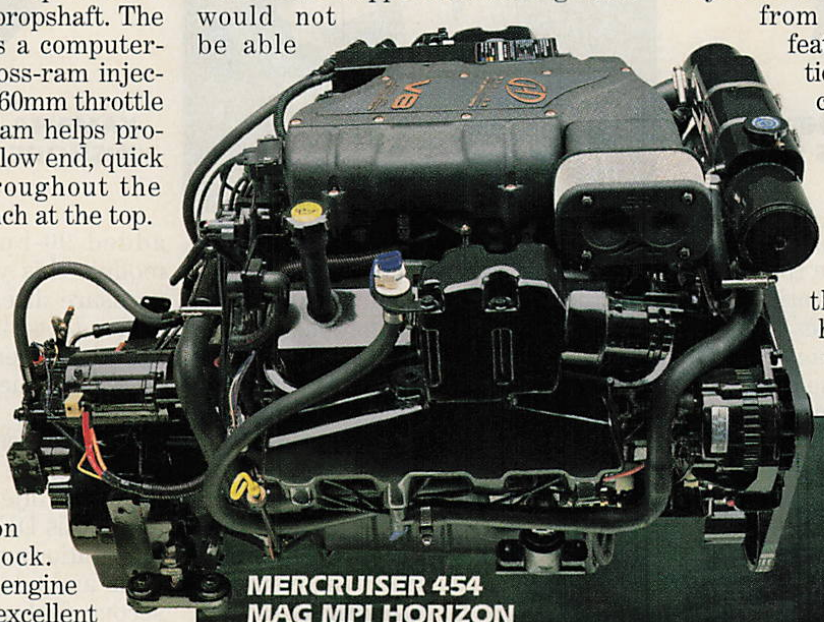
For shallow-water fishermen, Yamaha also introduces the Inshore 115. This engine is built to go on skiffs and flats boats that demand optimum shallow water performance. The V4 has a special lower unit with a shorter gearcase that allows the engine to be mounted higher, which reduces drag. The water pickup is placed low on the housing so the engine always gets proper cooling. And a wider cavitation plate traps water around the propeller, allowing the engine to run in extremely skinny water.

Yamaha also brings out two new 4-strokes, a 15 and a 25. The company is already showing a 100-hp 4-stroke that will be part of the '99 model year, and there's a rumor that somewhere in Japan, Yamaha has a 200-hp 4-stroke up and running. But the biggest thing in 4-strokes this year, literally, is the Honda 130.

TIGERSHARK TS 770

Only a few years ago, people were saying the 100-hp marine 4-stroke would never happen because engineers would not be able to hurdle the size and weight obstacles. But Honda, who builds nothing but 4-strokes, crushes the 100-hp barrier with this new engine. The inline 4-cylinder borrows a number of parts from the Honda Accord and features multiport fuel injection. It's an overhead-cam configuration and has—a boating industry first—twin balance shafts that reduce engine vibration and ensure supersmooth operation.

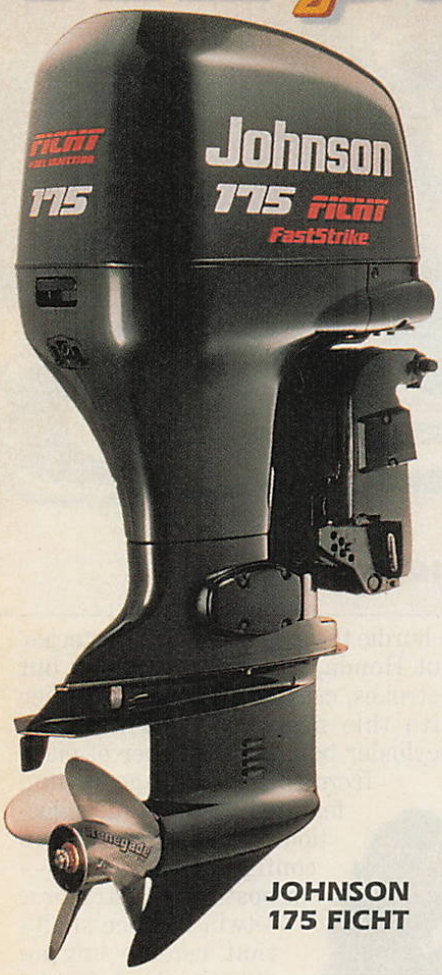
Honda may have been the first to surpass 100 hp, but they didn't have the first fuel-injected 4-strokes. Suzuki's new



MERCRUISER 454 MAG MPI HORIZON

YAMAHA VMAX 3.1-LITER 225

Boating '98



JOHNSON 175 FICHT

HONDA 130

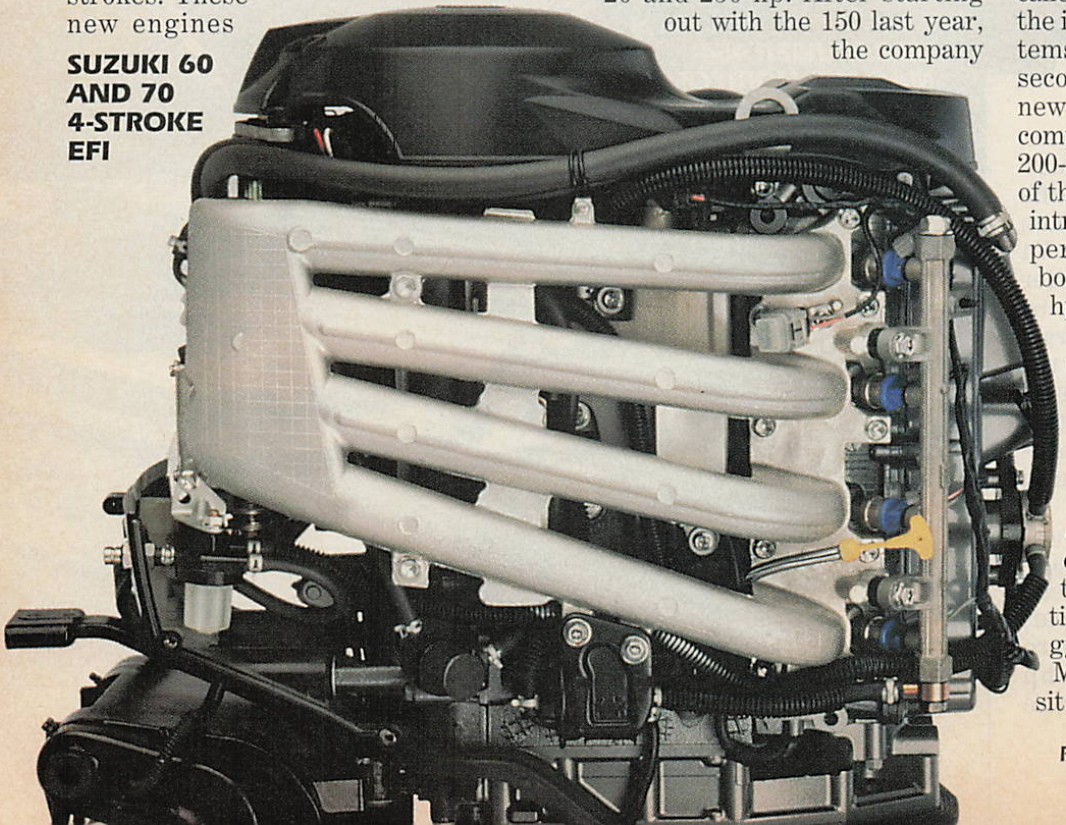
YAMAHA INSHORE 115

60-hp and 70-hp 4-strokes came out several months before the Honda, and they offer digital, sequential multiport injection. The engines also have water-cooled "long-track" intake manifolds that increase midrange power. Suzuki claims that these systems help reduce emissions by up to 15% and increase fuel economy by as much as 75% over comparable 2-strokes. These new engines have evolved from Suzuki's inline 4-cylinder car engine and they also feature the boating industry's first solid-state electronic ignition.

At OMC, the focus remains on implementation of the 2-stroke FICHT system that was introduced last year. Eventually, OMC plans to use the FICHT technology on all its Johnson and Evinrude outboards between 20 and 250 hp. After starting out with the 150 last year, the company added 90-hp, 115-hp and 175-hp models this year. So far, the high-pressure direct injection technology seems to be living up to its promise of reducing emissions by up to 80%, increasing fuel economy and running worry-free.

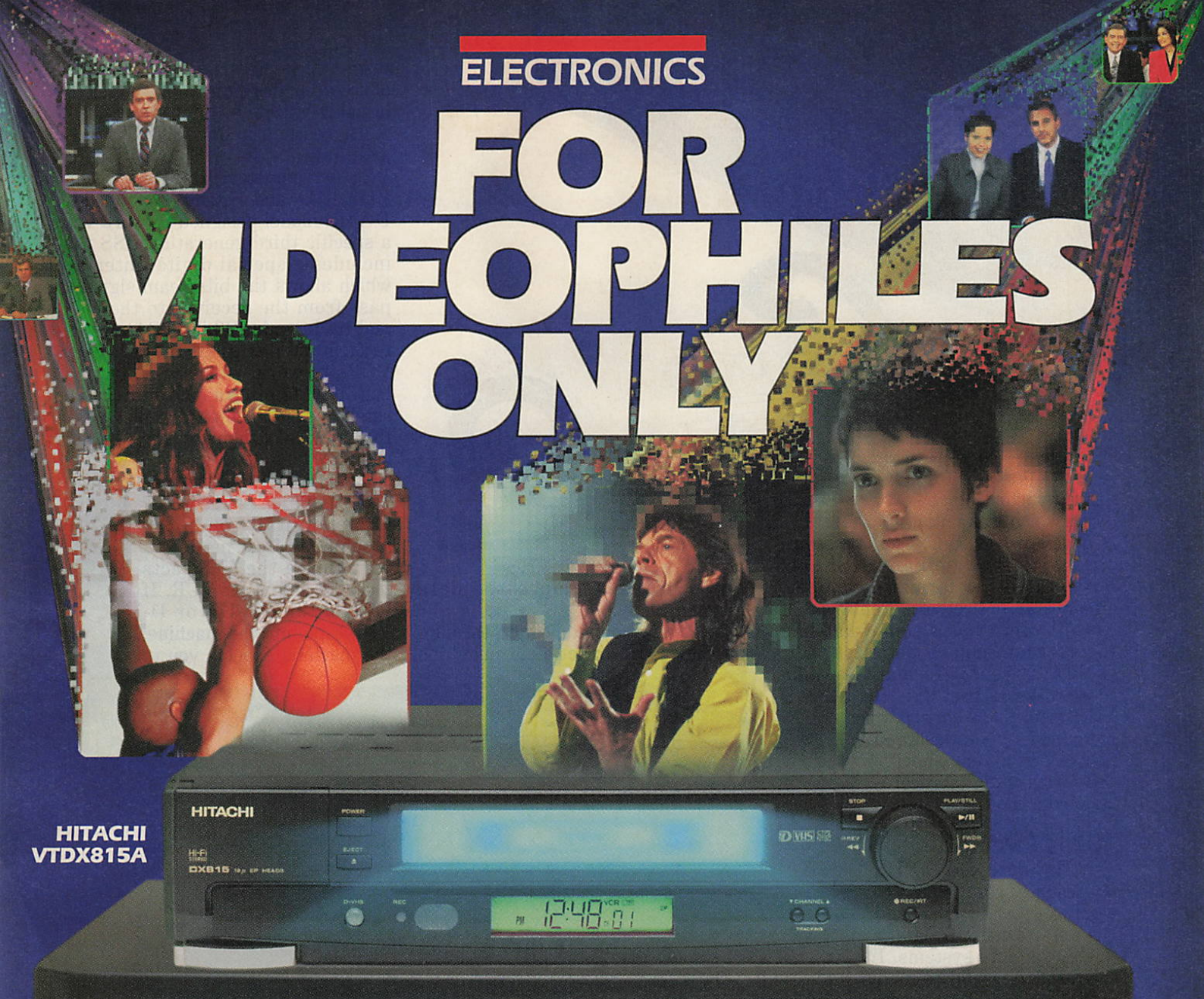
Not to be outdone, Mercury continues to replace its EFI engines with direct fuel injection. Last year, they called this DFI, but after redesigning the ignition and computer-control systems and adding a fuel cooler and a second fuel pump, they've given it a new name: OptiMax. Currently the company is producing 135-hp, 150-hp, 200-hp and 225-hp outboards as part of the OptiMax line. Mercury has also introduced a new line of short-shaft performance engines for the bass boat market, topped off by the 300-hp 3.0-liter ProMax.

Overall, most of the new product is aimed at meeting the mandate for reduced emissions, which culminates in 2006 with a 75% overall reduction. It's interesting, though, that the American-based builders—OMC and Mercury—seem to be favoring direct-injection 2-strokes while the Japanese companies are betting the farm on 4-stroke technology. Which is the better solution? Maybe we'll know by the time we sit down to write Boating '99. **PM**



SUZUKI 60 AND 70 4-STROKE EFI

FOR VIDEOPHILES ONLY



HITACHI VTDX815A

Digital VCRs are here. But high cost keeps them from being mainstream.

BY DENNIS BARKER; PM Photo by Michel Tcherevkoff

● In case you haven't noticed, the world is changing from analog to digital. For better or worse, the world is revolving more and more around 0s and 1s. Among today's technophiles, analog is perceived as cumbersome and mechanical. Digital, on the other hand, provides lightning-fast response.

The first digital products included computers and compact disc players. Within the last few years, digital camcorders, DSS (digital satellite systems), and DVD (digital video discs) have burst onto the electronics scene. Next year will bring digital television and high-definition television (HDTV) programming to market, now that the FCC has given final approval of channel allocation to the 1600 or so television stations across the country.

But you don't have to wait until next year to enjoy the incredible clarity and stunning definition of digital video. You don't have to wait a year or more to turn on your television and enjoy images totally free of distortion, snow, interference or picture noise. Trouble is, no television station will be generating these great video images for you in the near future. You'll have to generate them yourself—from a digital videocassette recorder.

Right now, a handful of digital VCRs are on the market. These units record images digitally—in 0s and 1s—and play them back at close to 500 lines of resolution. The picture quality is nothing short of stunning.

PHOTOS COUNTERCLOCKWISE FROM TOP LEFT: OUTLINE/P. CARRETTE; OUTLINE/HARRY J. SISKIND; CORBIS/MIKE HASHIMOTO/NGI; PHOTONICA/JACK HUTCHESON; CORBIS/JOHN BELLISSIMO; 20TH CENTURY FOX/SUZANNE TENNER; OUTLINE/CRAIG BLANKENHORN; OUTLINE/CRAIG BLANKENHORN

FOR VIDEOPHILES ONLY

There are currently two methods for digital recording. D-VHS, which was initially developed by JVC, uses a cassette similar to the familiar VHS tape. Sony, the other format developer, employs an entirely different type of cassette that looks somewhat like the current 8mm cassette for their D-VCR. Already, format wars like those of years past (like Beta versus VHS) loom on the horizon. Each format has been designed to work in a very specific way to make digital recordings from another source.

JVC's D-VHS

The JVC-designed D-VHS is presently constructed to work only with DSS and Echostar Direct-to-Home (DTH) satellite systems. In the future, it could be modified to work with HDTV or a set-top high-definition box.

JVC has been developing D-VHS for the past several years in hopes of being at the forefront of the coming digital age. Co-developers are Hitachi and Thomson Consumer Electronics, the parent of RCA, ProScan and GE. Both RCA and Hitachi plan to bring product to market right about now in conjunction with their third-generation DSS products. According to JVC, D-VHS is a new videotape technology which is based on VHS. In addition to offering all of the features of regular VCRs, this new VHS technology offers bitstream recording capability. With bitstream recording, the compressed digital data, such as the encrypted signals in digital broadcasts, can be recorded directly to tape and played back without being decompressed—if your set-top box has this capability.

In setups where you already have devices that are capable of decompressing signals that are received in a compressed form, such as those received by a set-top box from a digital satellite receiver, D-VHS can record the compressed data stream directly.

The 2-way communication through the digital interface also provides such additional features as a "virtual keypad" that appears on screen to enable the user to control the VCR via an easy-to-understand display.

The big bonus to D-VHS is that it's backward compatible, meaning that conventional VHS (including VHS-C) and S-VHS tapes will play back on the new D-VHS machines.

D-VHS offers three types of recording modes:

TD mode inputs data at a rate of 14.1 Mbps with a standard recording time of 5 hours (31.7GB) or a max recording time of 7 hours using a thin T-120 tape (44.7GB).

HD mode inputs data at a rate of 28.2 Mbps with a standard recording time of 2 hours and 30 minutes or 3 hours and 30 minutes.

LP mode offers a low-rate, long-time recording to a maximum of 49 hours at 2 Mbps setting. D-VHS has a drum rotation of 1800 rps with a recording rate of 19.1 Mbps using a CTL tracking system and an SI-NRZI modulation system. Under the present scheme, only the STD mode of recording is being employed for the initial D-VHS units offered.

Currently, the only digital signals available for D-VHS VCRs are on DSS or Echostar satellite systems. Both RCA and Hitachi announced a D-VHS model designed to work with a specific third-generation DSS that includes a special digital interface which allows the bitstream signal to pass from the receiver to the VCR and back again. While RCA and Hitachi have designed their D-VHS VCRs to work with DSS only, JVC has opted to place a built-in Echostar satellite-system tuner/decoder within the confines of their D-VHS cabinet.

The D-VHS VCR gives you the option of recording either digitally or in the normal analog mode, in which case the VCR acts just like any other VCR. If you put an S-VHS or D-VHS tape into the machine, the machine expects you to press the D-VHS button. Then the VCR takes over and switches the line inputs accordingly.

While virtually any image on DSS or Echostar has the capability of being recorded, copy protection is built directly into the bitstream itself, called the Copy Protection Management System-Digital.

D-VHS Hardware Now Available

RCA has introduced a D-VHS VCR and two accompanying DSS receivers. Besides being DVHS-ready, RCA's new top-of-the-line DSS satellite receiver—the $599 DS745ORB—now includes a dipole antenna built into the 18-in. satellite dish to make receiving local programming easier. The RCA VR911HF, priced at $600 list, is a full-featured 4-head HiFi VCR that will digitally record up to 500 lines of resolution. It is designed to work with selected DSS receivers from RCA, ProScan and Hitachi. Hitachi has also introduced a D-VHS VCR and an ac-

companying DSS receiver. Hitachi's VTDX815A is a D-VHS VCR with the capability of digitally recording 500 lines of resolution and providing CD-quality sound. It is priced at $599.95. This Dual Azimuth 4-head HiFi VCR is capable of receiving 181 channels and features auto clock set and an 8-event/1-year programmable timer housed in a full-width component cabinet. The DSS companion model is Hitachi's HDS220A, which includes a 16-event timer with one-button RECORD (via StarSight) as well as a 32-event timer/scheduler.

JVC has come up with a much neater solution that allows the user to buy only one new component. It has introduced the HM-DSR100 D-VHS Digital Satellite Recorder, which combines an 8-head HiFi D-VHS VCR and a fully featured EchoStar Dish Network's tuner/decoder into one box. This single-unit design makes receiving and recording digital images much easier. It allows digital bitstream recording of Dish Network's digital MPEG2 signal. Conversion of the signal only occurs upon playback. Unlike RCA and Hitachi units that utilize a modified IEEE 1394 cable to tether the VHS recorder and DSS receiver, the only basic external connections required are to the TV, the antennas and an AC outlet.

The DSR100 uses a multibrand UHF/IR universal remote (with a range of 100 ft. between rooms) to control TV and audio equipment. A parental V-chip is also included so that parents may allow program access based on ratings and content.

The HM-DSR100 is priced at $999 and includes an 18-in. dish. It can be purchased without the dish for $50 less.

Sony D-VCR

The Sony system, supported by Matsushita, the parent of Panasonic, is designed to work with its new breed of digital camcorders, ensuring that the highest-quality image is maintained as it is dubbed from camcorder to VTR (video tape recorder).

Sony, as always, has taken an entirely different approach to making digital recordings with their DVC technology. Like D-VHS, this digital format provides picture quality of up to 500 lines of horizontal resolution with no color blur and an extremely stable picture incorporating CD-quality sound. Designed to work with digital DVC camcorders, the format provides drop-frame time code and cassette memory for accurate editing and convenient indexing of tape. Sony's focus is clearly on upscale editing utilizing IEEE 1394 "firewire" 2-way communication between digital DVC camcorders, personal computers, and other electronic devices with their DVC VCR. This guarantees virtually no picture quality loss when tapes are edited on the deck. However, it should be noted that off-air (e.g., DSS) digital recording with DVC is not presently possible.

The Sony DHR-1000, priced at $4199, is designed for the serious videographer. It features a dual-well cassette mechanism that enables the deck to play back and record both standard and mini-DV cassettes without requiring a special adapter.

The DHR-1000 provides PCM audio (16-bit/48-kHz—one stereo track—or 12-bit/32-kHz—two stereo tracks) along with a built-in MTS stereo tuner and audio level meters.

Several Sony DV cassettes are available with or without a special memory chip. Sony DV tapes incorporate advanced double Metal Evaporated layers for higher output and lower noise. The two recording layers incorporate a DLC (Diamond-Like Carbon) layer that reportedly helps tape durability. A special back-coating also helps reduce friction between the tape and guide pins, which supposedly promotes stable tape transport. Both mini-DV 6mm and standard ¼-in. DV digital videocassettes offer 500 lines of resolution. Sony tapes are available in 30-minute, 60-minute, 120-minute and 180-minute lengths.

Panasonic markets a mini-DV tape in 6-minute, 12-minute, 23-minute, 33-minute and 63-minute lengths. Panasonic's standard DV tape lengths include 54-minute, 94-minute and 123-minute cassettes.

Also supporting the DV format, Panasonic Broadcast & Television System Co. offers its AJ-D230 DVCPRO desktop VTR, which features a built-in RS-232C interface for PC control. It is priced at $4995. It accepts both large- and medium-size DVCPRO cassettes and plays back mini-DV cassettes with an adapter. The AJ-D230 DVCPRO is somewhat unique in that it is only 9.5 in. wide (two will easily fit side by side on a rack).

Today And Tomorrow

The Sony DHR-1000 and Panasonic AJ-D230 DVCPRO are clearly designed for serious videophiles who want to edit their digital videos from either their digital camcorder or computer.

The Hitachi and RCA D-VHS VCRs are designed for people who want the same high-quality images they normally get with DSS. Unfortunately, you have to purchase both the VCR and the new DSS receiver to enjoy digital recording.

No matter which way you decide to go, be ready to shell out plenty of moola. The privilege of recording digitally doesn't come easily and it doesn't come cheap. PM

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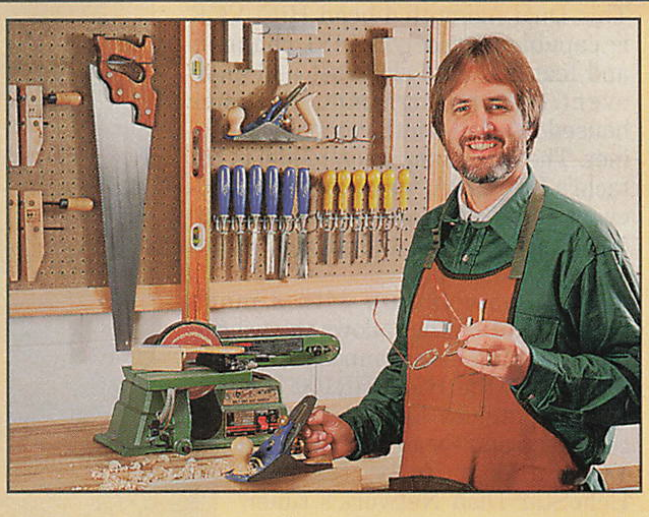

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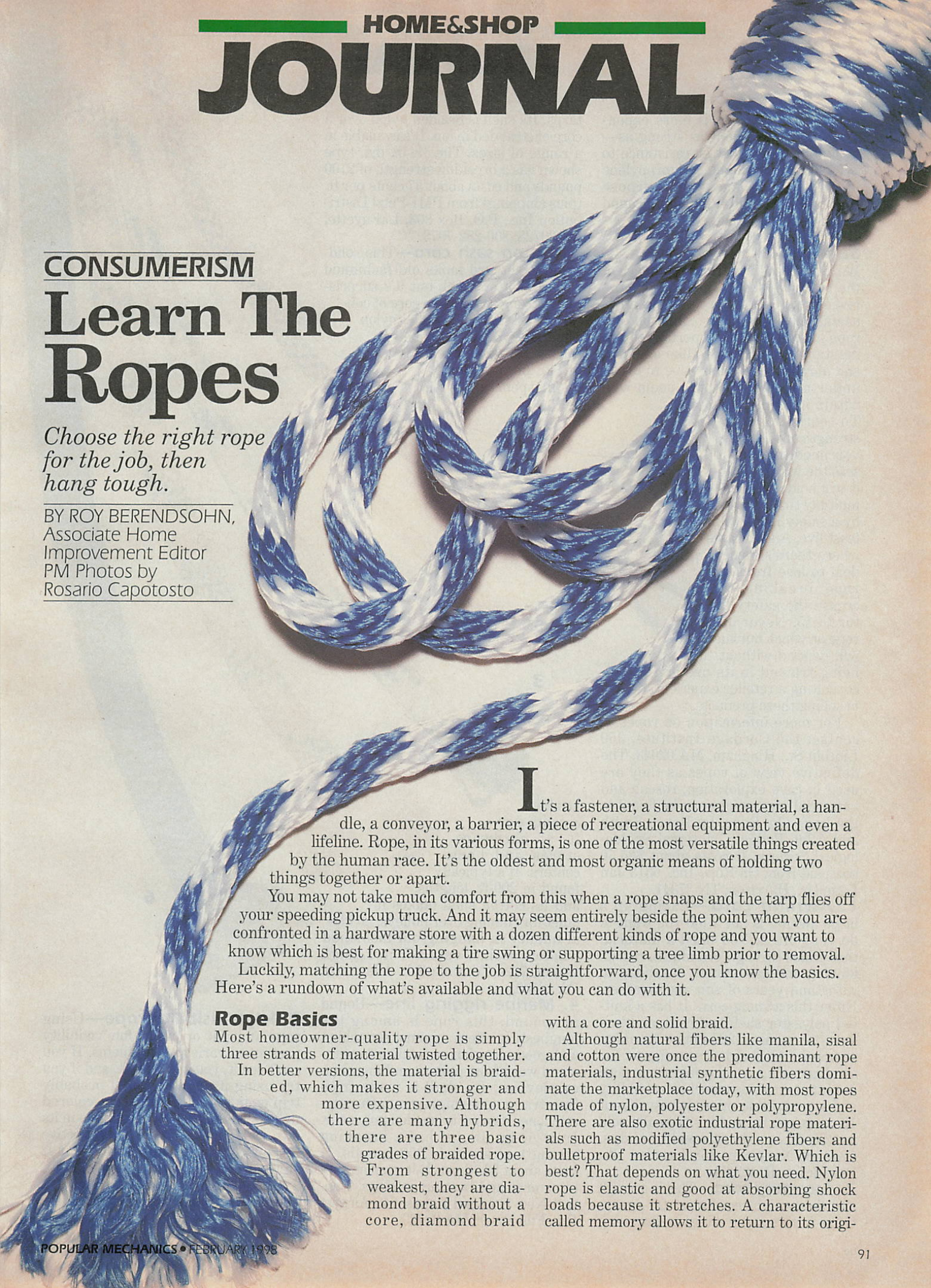


CONSUMERISM

Learn The Ropes

Choose the right rope for the job, then hang tough.

BY ROY BERENDSOHN,
Associate Home Improvement Editor
PM Photos by Rosario Capotosto

It's a fastener, a structural material, a handle, a conveyor, a barrier, a piece of recreational equipment and even a lifeline. Rope, in its various forms, is one of the most versatile things created by the human race. It's the oldest and most organic means of holding two things together or apart.

You may not take much comfort from this when a rope snaps and the tarp flies off your speeding pickup truck. And it may seem entirely beside the point when you are confronted in a hardware store with a dozen different kinds of rope and you want to know which is best for making a tire swing or supporting a tree limb prior to removal.

Luckily, matching the rope to the job is straightforward, once you know the basics. Here's a rundown of what's available and what you can do with it.

Rope Basics

Most homeowner-quality rope is simply three strands of material twisted together. In better versions, the material is braided, which makes it stronger and more expensive. Although there are many hybrids, there are three basic grades of braided rope. From strongest to weakest, they are diamond braid without a core, diamond braid with a core and solid braid.

Although natural fibers like manila, sisal and cotton were once the predominant rope materials, industrial synthetic fibers dominate the marketplace today, with most ropes made of nylon, polyester or polypropylene. There are also exotic industrial rope materials such as modified polyethylene fibers and bulletproof materials like Kevlar. Which is best? That depends on what you need. Nylon rope is elastic and good at absorbing shock loads because it stretches. A characteristic called memory allows it to return to its origi-

nal shape. Polyester is more expensive than—and about as strong as—nylon, and it has better resistance to abrasion and sunlight. Polypropylene is a good, inexpensive all-purpose rope material, and it's handy around water because it floats.

Safety

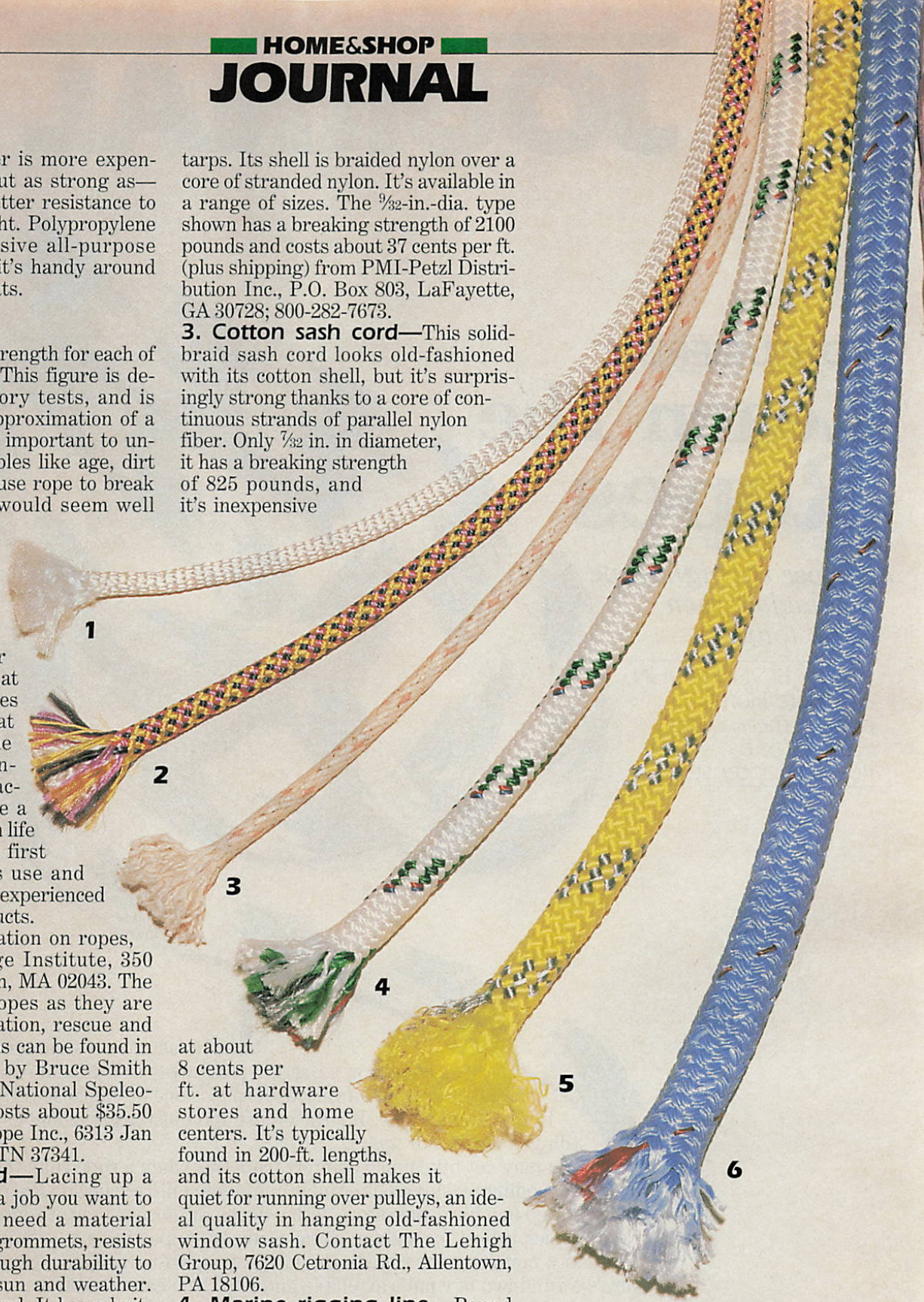
We list a breaking strength for each of the ropes we show. This figure is derived from laboratory tests, and is useful only as an approximation of a rope's strength. It's important to understand that variables like age, dirt and abrasion can cause rope to break under a load that would seem well within its capacity. To estimate the strength of the rope you need, first assess the weight that it will hold and then multiply that number by a safety factor of at least five. And in cases where there's a great deal to lose from the rope breaking, increase the safety factor to 15. Never use a rope on which human life will depend without first being trained in its use and consulting a retailer experienced in selling these products.

For more information on ropes, contact the Cordage Institute, 350 Lincoln St., Hingham, MA 02043. The definitive view of ropes as they are used in cave exploration, rescue and industrial occupations can be found in the book *On Rope*, by Bruce Smith and Allen Padgett, National Speleological Society. It costs about $35.50 postpaid from On Rope Inc., 6313 Jan Lane Dr., Harrison, TN 37341.

1. Awning cord—Lacing up a large awning is not a job you want to do very often. You need a material that glides through grommets, resists kinking and has enough durability to withstand years of sun and weather. Enter this awning cord. It has a knitted polyester shell and core, and in a ¼-in dia. it has a 1200-pound breaking strength. Although it's designed for awnings, it's a good general-purpose cord that combines mechanical ability and a reasonable price. It costs about 16 cents per ft., and it's typically sold in 250-ft. spools at awning shops. Contact NeoCorp, 358 Lowden St., Pawtucket, RI 02860.

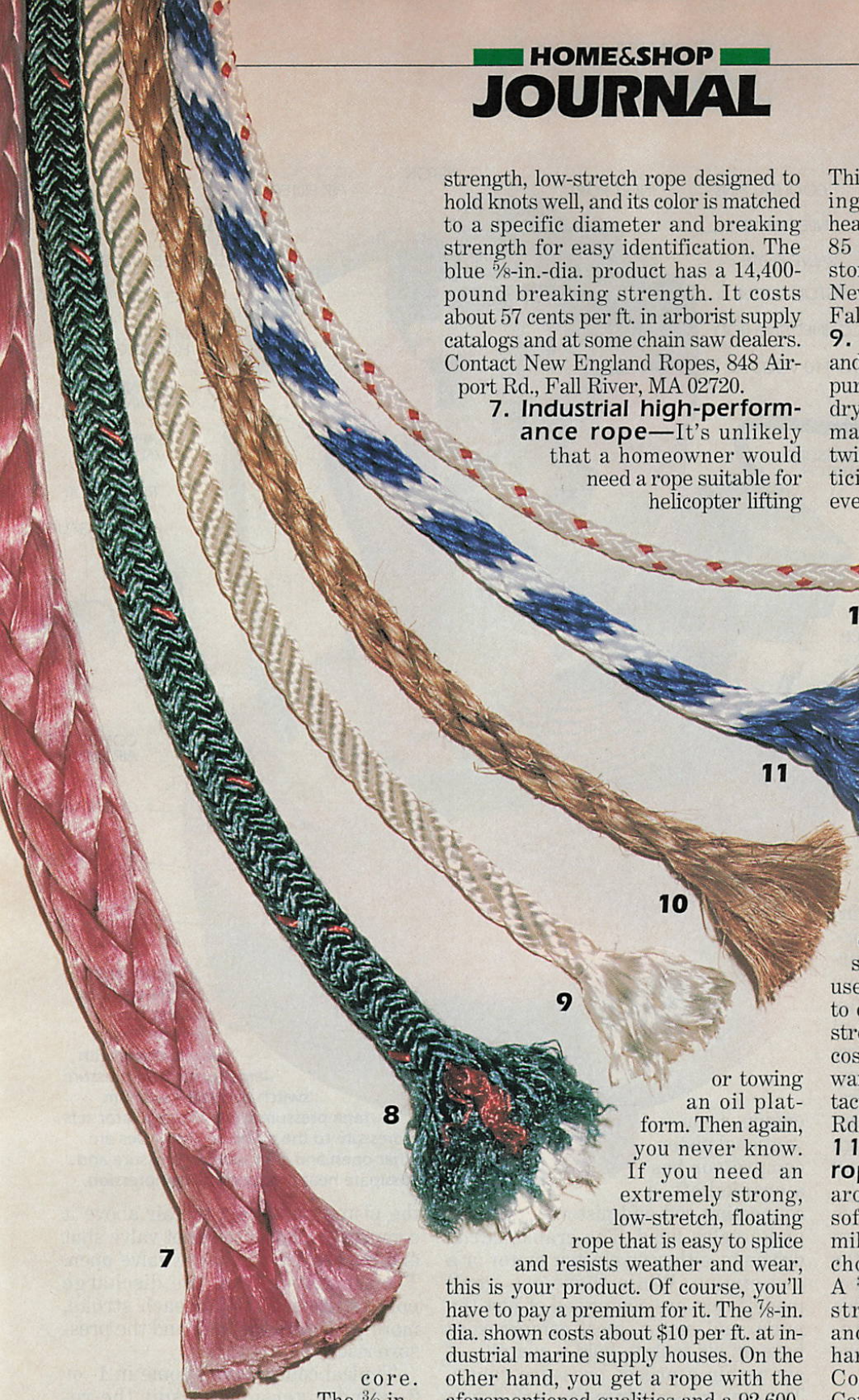
2. Accessory cord—This is a tough and lightweight cord used for everything from making slings to fastening tarps. Its shell is braided nylon over a core of stranded nylon. It's available in a range of sizes. The 9/32-in.-dia. type shown has a breaking strength of 2100 pounds and costs about 37 cents per ft. (plus shipping) from PMI-Petzl Distribution Inc., P.O. Box 803, LaFayette, GA 30728; 800-282-7673.

3. Cotton sash cord—This solid-braid sash cord looks old-fashioned with its cotton shell, but it's surprisingly strong thanks to a core of continuous strands of parallel nylon fiber. Only 7/32 in. in diameter, it has a breaking strength of 825 pounds, and it's inexpensive at about 8 cents per ft. at hardware stores and home centers. It's typically found in 200-ft. lengths, and its cotton shell makes it quiet for running over pulleys, an ideal quality in hanging old-fashioned window sash. Contact The Lehigh Group, 7620 Cetronia Rd., Allentown, PA 18106.



4. Marine rigging line—Pound for pound, this rope is among the toughest. It offers minimal stretching and good abrasion resistance to withstand wear from pulleys and mechanical devices. Its shell is made from Spectra, a superhigh-strength polyethylene. Its core is braided polyester. In a 7/16-in. dia., it has a breaking strength of about 14,300 pounds. It costs about $3.10 per ft. in marine supply stores and boating catalogs. Contact New England Ropes, 848 Airport Rd., Fall River, MA 02720.

5. High-visibility rope—Using rope at night or under low visibility presents a variety of problems. If you can't see it, you can't use it, and if you try using it anyway, you'll probably trip over it. The fluorescent-colored nylon shell on this rope is visible in its own right, but it also has a reflective material braided into it, so that it shines when struck by a beam of light. The rope has a continuous core of parallel nylon strands, and it's available in a floating version with a polypropylene



core. The ⅜-in.-dia. type shown has a 5200-pound breaking strength. It costs about 71 cents per ft. (plus shipping) from PMI-Petzl Distribution Inc., P.O. Box 803, LaFayette, GA 30728; 800-282-7673.

6. Polyester bull rope—If you have to remove a tree limb or the tree itself, you'd better have a rope that's up to the job, such as this arborist product. It's made from finely woven, double-braided polyester that resists the wear and tear from tree bark. It's a high-strength, low-stretch rope designed to hold knots well, and its color is matched to a specific diameter and breaking strength for easy identification. The blue ⅝-in.-dia. product has a 14,400-pound breaking strength. It costs about 57 cents per ft. in arborist supply catalogs and at some chain saw dealers. Contact New England Ropes, 848 Airport Rd., Fall River, MA 02720.

7. Industrial high-performance rope—It's unlikely that a homeowner would need a rope suitable for helicopter lifting or towing an oil platform. Then again, you never know. If you need an extremely strong, low-stretch, floating rope that is easy to splice and resists weather and wear, this is your product. Of course, you'll have to pay a premium for it. The ⅞-in. dia. shown costs about $10 per ft. at industrial marine supply houses. On the other hand, you get a rope with the aforementioned qualities and a 92,600-pound breaking strength. It's made from polyurethane-finished Plasma, a form of industrial polyethylene fiber. Contact Puget Sound Rope, 1012 Second St., Anacortes, WA 98221.

8. Double-braid nylon line—If you want a high-strength rope with good resistance to abrasion and easy handling, then you might choose this teal-colored line designed for marine use. Both its core and its shell are braided, giving the ⅝-in.-dia. product a breaking strength of 13,500 pounds. This makes it a good choice for docking and anchor line or other wet, heavy-duty applications. It costs about 85 cents per ft. in marine supply stores and boating catalogs. Contact New England Ropes, 848 Airport Rd., Fall River, MA 02720.

9. Nylon anchor line—Anchor and marine-use lines are good general-purpose products even when used on dry land. This ⅜-in.-dia. anchor line is made from three strands of nylon twisted together. It offers good elasticity and retains its high strength even when wet. This type has a breaking strength of about 3300 pounds and costs about 20 cents per ft. at hardware stores and home centers. Contact Samson Ropes, The Lehigh Group, 7620 Cetronia Rd., Allentown, PA 18106.

10. Manila rope—This is the real thing: old-fashioned, 100% manila, oily odor and all. Manila is the strongest natural rope fiber, and it has high heat resistance, which made it popular in industrial applications years ago. Although it is resistant to sunlight, it will rot if it is used outdoors without being allowed to dry. In ⅜-in. dia. it has a breaking strength of about 1200 pounds, and it costs about 18 cents per ft. at hardware stores and home centers. Contact The Lehigh Group, 7620 Cetronia Rd., Allentown, PA 18106.

11. Braided polypropylene rope—This braided rope is handy around water because it floats. It's soft but durable, highly visible and mildew resistant, making it a good choice for suspending pool floats. A ⅜-in.-dia. line has a breaking strength of about 2440 pounds and costs about 20 cents per ft. at hardware stores and home centers. Contact The Lehigh Group, 7620 Cetronia Rd., Allentown, PA 18106.

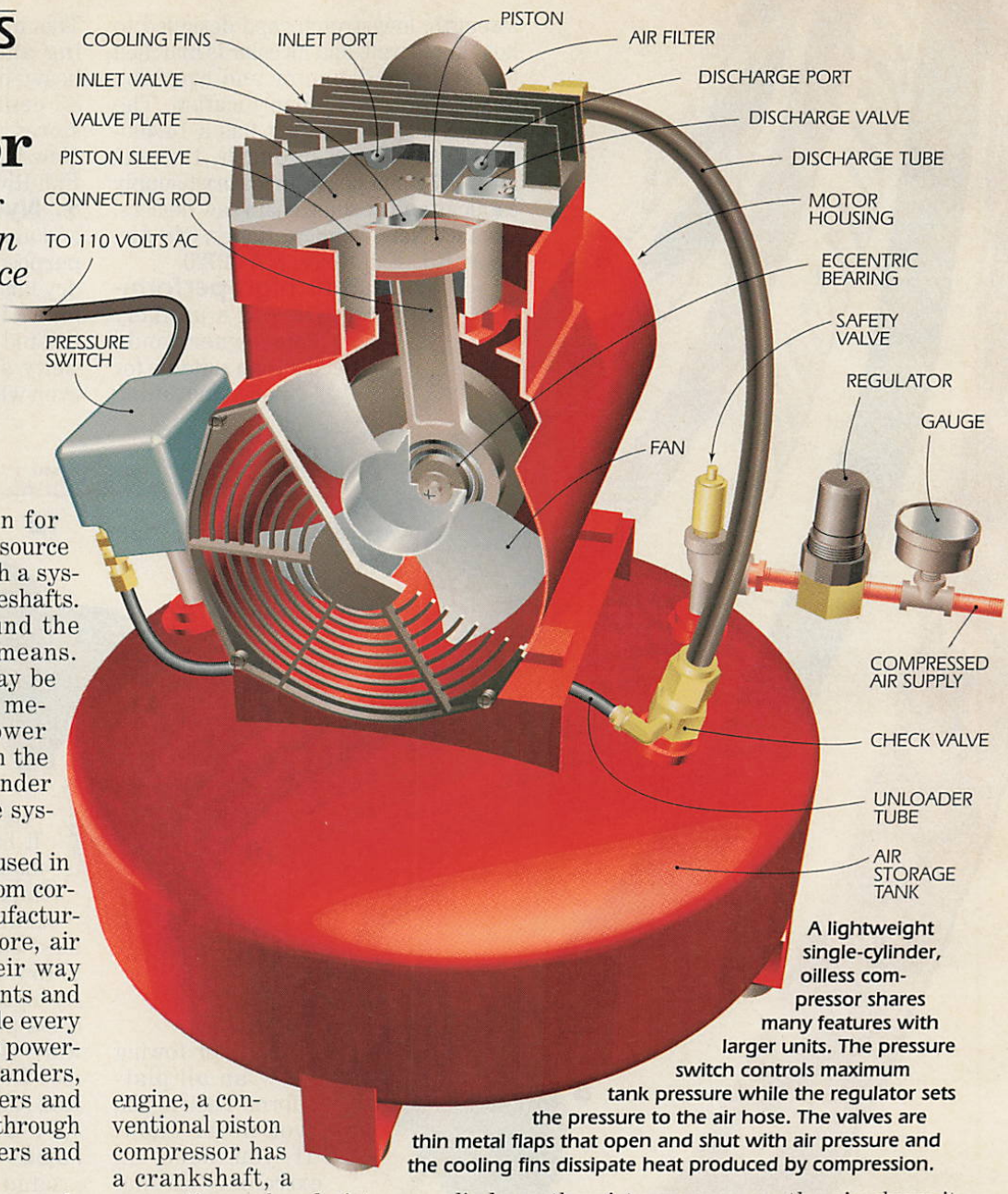
12. Braided polyester cord—When you want to run your flag up the pole, this diamond-braid polyester rope is a good, long-wearing choice. It resists sunlight, abrasion, chemicals and water. The 3/16-in.-dia. size is more than strong enough for most household jobs. It has a breaking strength of about 900 pounds, costs about 8 cents per ft. and is sold at hardware stores and home centers. Contact The Lehigh Group, 7620 Cetronia Rd., Allentown, PA 18106. PM

HOW IT WORKS

Air Compressor

More than a tool for inflating tires, it's an alternate power source for your shop.

BY THOMAS KLENCK, Associate Home Editor
PM Illustrations by Eugene Thompson



A lightweight single-cylinder, oilless compressor shares many features with larger units. The pressure switch controls maximum tank pressure while the regulator sets the pressure to the air hose. The valves are thin metal flaps that open and shut with air pressure and the cooling fins dissipate heat produced by compression.

● Years ago, it was common for shops to have a central power source that drove all the tools through a system of belts, wheels and driveshafts. The power was routed around the work space by mechanical means. While the belts and shafts may be gone, many shops still use a mechanical system to move power around the shop. It's based on the energy stored in air that's under pressure, and the heart of the system is the air compressor.

You'll find air compressors used in a wide range of situations—from corner gas stations to major manufacturing plants. And, more and more, air compressors are finding their way into home workshops, basements and garages. Models sized to handle every job, from inflating pool toys to powering tools such as nail guns, sanders, drills, impact wrenches, staplers and spray guns are now available through local home centers, tool dealers and mail-order catalogs.

The big advantage of air power is that each tool doesn't need its own bulky motor. Instead, a single motor on the compressor converts the electrical energy into kinetic energy. This makes for light, compact, easy-to-handle tools that run quietly and have fewer parts that wear out.

Air compressor types

While there are compressors that use rotating impellers to generate air pressure, positive-displacement compressors are more common and include the models used by homeowners, woodworkers, mechanics and contractors. Here, air pressure is increased by reducing the size of the space that contains the air. Most of the compressors you'll run across do this job with a reciprocating piston.

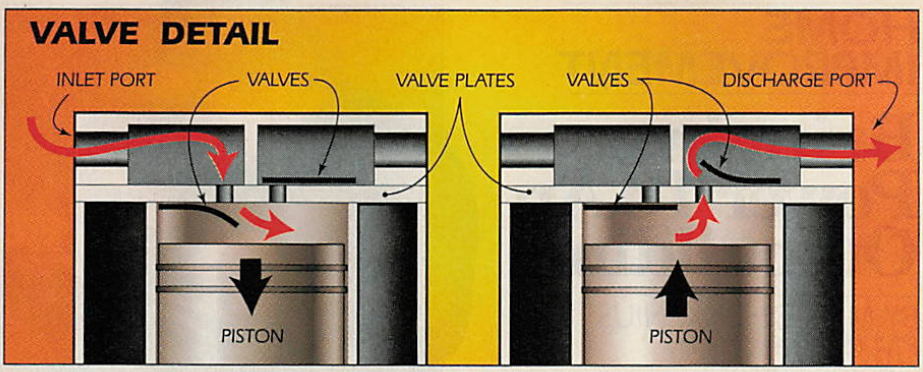
Like a small internal combustion engine, a conventional piston compressor has a crankshaft, a connecting rod and piston, a cylinder and a valve head. The crankshaft is driven by either an electric motor or a gas engine. While there are small models that are comprised of just the pump and motor, most compressors have an air tank to hold a quantity of air within a preset pressure range. The compressed air in the tank drives the air tools, and the motor cycles on and off to automatically maintain pressure in the tank.

At the top of the cylinder, you'll find a valve head that holds the inlet and discharge valves. Both are simply thin metal flaps—one mounted underneath and one mounted on top of the valve plate. As the piston moves down, a vacuum is created above it. This allows outside air at atmospheric pressure to push open the inlet valve and fill the area above the piston. As the piston moves up, the air above it compresses, holds the inlet valve shut and pushes the discharge valve open. The air moves from the discharge port to the tank. With each stroke, more air enters the tank and the pressure rises.

Typical compressors come in 1- or 2-cylinder versions to suit the requirements of the tools they power. On the homeowner/contractor level, most of the 2-cylinder models operate just like single-cylinder versions, except that there are two strokes per revolution instead of one. Some commercial 2-cylinder compressors are 2-stage compressors—one piston pumps air into a second cylinder that further increases pressure.

Compressors use a pressure switch to stop the motor when tank pressure reaches a preset limit—about 125 psi

for many single-stage models. Most of the time, though, you don't need that much pressure. Therefore, the air line will include a regulator that you set to match the pressure requirements of the tool you're using. A gauge before the regulator monitors tank pressure and a gauge after the regulator monitors air-line pressure. In addition, the tank has a safety valve that opens if the pressure switch malfunctions. The pressure switch may also incorporate an unloader valve that reduces tank pressure when the compressor is turned off.



As the piston moves down, the vacuum created allows outside air to push open the inlet valve (left). During compression (right), the inlet valve shuts while air is pressed into tank.

Many articulated-piston compressors are oil lubricated. That is, they have an oil bath that splash-lubricates the bearings and cylinder walls as the crank rotates. The pistons have rings that help keep the compressed air on top of the piston and keep the lubricating oil away from the air. Rings, though, are not completely effective, so some oil will enter the compressed air in aerosol form.

Having oil in the air isn't necessarily a problem. Many air tools require oiling, and inline oilers are often added to increase a uniform supply to the tool. On the down side, these models require regular oil checks, periodic oil changes and they must be operated on a level surface. Most of all, there are some tools and situations that require oilfree air. Spray painting with oil in the airstream will cause finish problems. And many new woodworking air tools such as nailers and sanders are designed to be oilfree so there's no chance of fouling wood surfaces with oil. While solutions to the airborne oil problem include using an oil separator or filter in the air line, a better idea is to use an oilfree compressor that uses permanently lubricated bearings in place of the oil bath.

A variation on the automotive-type piston compressor is a model that uses a one-piece piston/connecting rod. Because there is no wrist pin, the piston leans from side to side as the eccentric journal on the shaft moves it up and down. A seal around the piston maintains contact with the cylinder walls and prevents air leakage.

Where air requirements are modest, a diaphragm compressor can be effective. In this design, a membrane between the piston and the compression chamber seals off the air and prevents leakage.

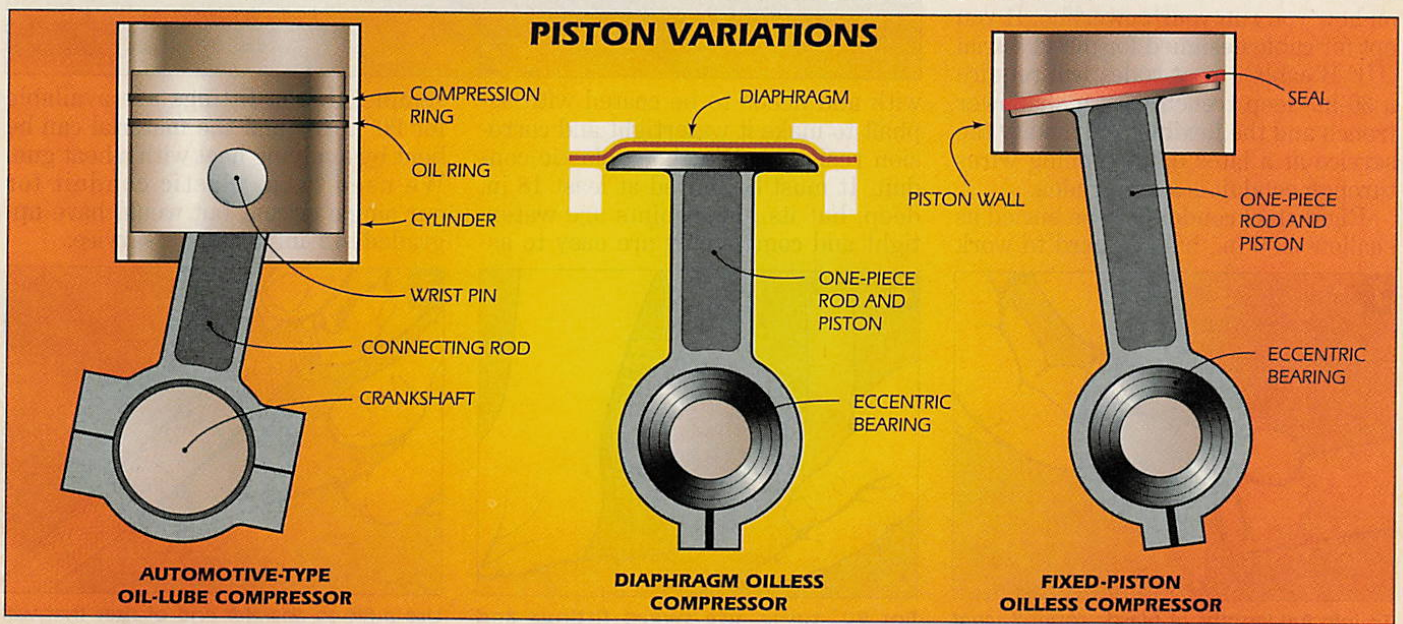
Compressor power

One of the factors used to designate compressor power is motor horsepower. However, this isn't the best indicator. You really need to know the amount of air the compressor can deliver at a specific pressure.

The rate at which a compressor can deliver a volume of air is noted in cubic feet per minute (cfm). Because atmospheric pressure plays a role in how fast air moves into the cylinder, cfm will vary with atmospheric pressure. It also varies with the temperature and humidity of the air. To set an even playing field, makers calculate standard cubic feet per minute (scfm) as cfm at sea level with 68° F air at 36% relative humidity. Scfm ratings are given at a specific pressure—3.0 scfm at 90 psi, for example. If you reduce pressure, scfm goes up, and vice versa.

You also may run across a rating called displacement cfm. This figure is the product of cylinder displacement and motor rpm. In comparison with scfm, it provides an index of compressor pump efficiency.

The cfm and psi ratings are important because they indicate the tools that a particular compressor can drive. When choosing a compressor, make sure it can supply the amount of air and the pressure that your tools need. PM



A positive displacement compressor compresses air by reducing the size of the space that contains the air. In most cases, this is achieved with a piston. Piston type and lubrication method are two variables that affect compressor design and application.

HOME IMPROVEMENT

Bringing Power To An Outbuilding

BY MERLE HENKENIUS
PM Illustrations by George Retseck

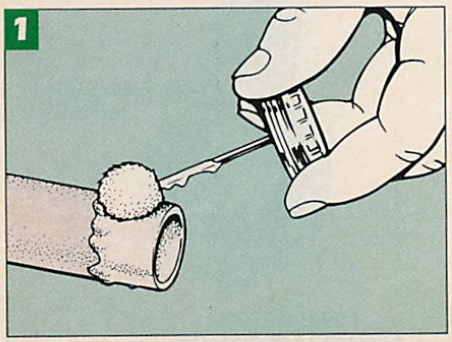
● Whether you've built a new garage that needs electricity or you'd simply like to energize your garden shed, the solution is much the same. In most cases, the best strategy is a buried powerline that extends from your house. Once the trench has been dug, all that's required is some basic hardware and a few simple connections.

In our installation, we ran one 20-amp, 120v circuit from the house to supply a switched ceiling light and several outlets. Bringing substantially more power outside will increase the scope of the job and may require a subpanel in the outbuilding.

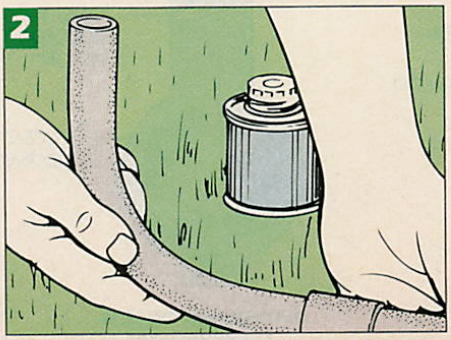
Before starting, visit your local building codes office to find out the requirements for the job. Code authorities can explain your underground options, and they may be able to point out any buried utilities. If your area is one of the many that has a one-call phone service that provides information on buried utilities, make the call to have a representative from each utility check out your property.

The depth of your trench depends on how you run your powerline. If you opt for cable designed for direct burial (UF-B cable), most codes will require a 30-in.-deep trench. For a shallower trench and the flexibility to modify the service at a later date, running wires through conduit is a better idea.

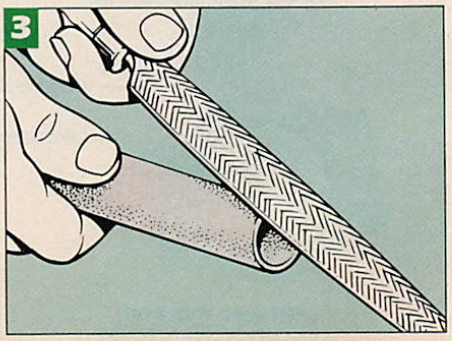
Rigid steel conduit can be buried as shallow as 6 in., but it's hard to work with and needs to be coated with asphalt to make it watertight and corrosion resistant. We chose plastic conduit. It must be buried at least 18 in. deep, but its glued joints are watertight and components are easy to assemble. Sweep fittings are available for 90° turns and the material can be bent by applying heat with a heat gun. We used ¾-in. plastic conduit for our single circuit, but would have upgraded to 1-in. for a 240v service.



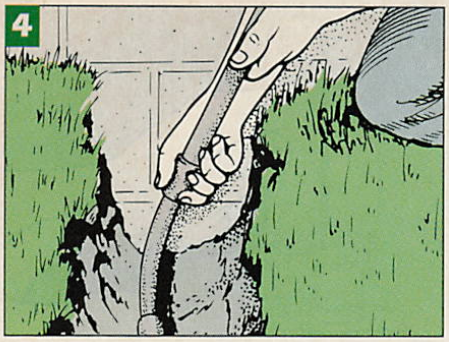
To join full lengths of plastic conduit, coat the end joint with PVC cement, insert the conduit and twist one-quarter of a turn.



For 90° turns, use sweep fittings and couplings. Glue together all plastic components with PVC cement.

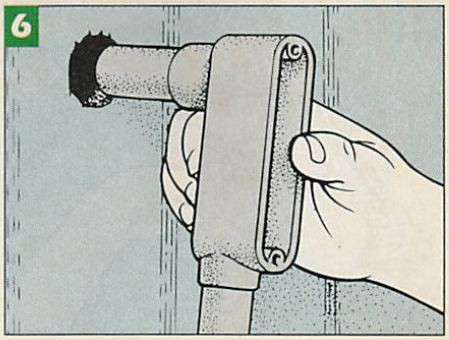


Use a file to chamfer end of riser that will extend vertically from the sweep, so it's ready for the slip coupling.

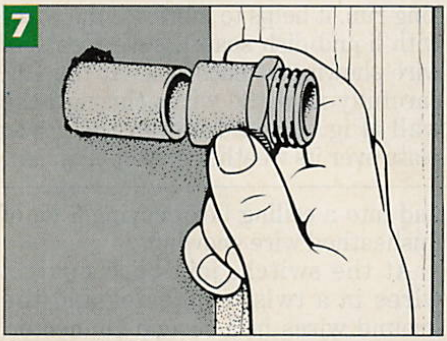


Glue the unchamfered end of the riser into the sweep fitting and move the riser up next to the foundation.

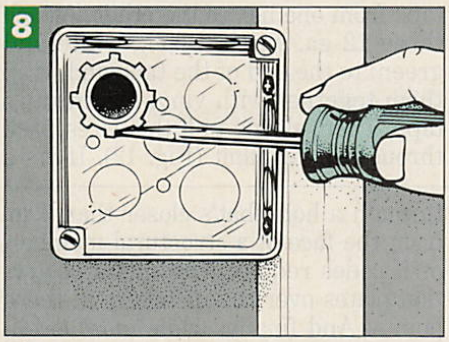
Slide the slip coupling over the chamfered riser and push it down until it's about 1 in. from bottoming out.



Insert a stub of conduit into the LB's right-angle fitting. Glue LB to the riser and press the stub through the wall.



Press a plastic male adapter onto the stub and use the junction box to establish the final length of the stub.



Glue the stub and male adapter in place, mount the box and tighten a locknut onto the adapter.

Running Conduit

Plastic conduit comes in 10-ft. lengths, and each piece has a female hub on one end for joining with another section. To join full lengths, apply PVC cement to the hub of one piece and to the plain end of the next (Fig. 1). Push the pieces together and twist one-quarter of a turn to spread the glue over the mating surface and speed the bond. Join cut lengths of conduit with couplings.

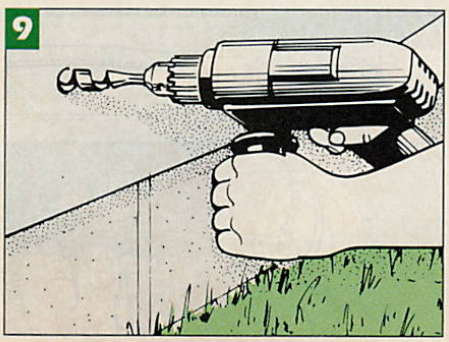
After digging the trench, assemble the conduit and use 90° sweep fittings at each foundation to bring the conduit up the wall. Use couplings and PVC cement to join the sweeps to the horizontal run (Fig. 2). Then, measure and cut vertical lengths to extend at least 1 ft. above grade. Most codes require a slip coupling at this point. Before gluing the vertical length, chamfer one end with a file (Fig. 3). Glue the opposite end to the sweep (Fig. 4). The slip coupling is a sleeve with a hub at the top and a lubricated O-ring near the bottom. It allows the buried conduit to move slightly as the soil settles. Slide the coupling's lower end over the chamfered riser (Fig. 5). Push it down to within an inch of bottoming out.

When entering a building with conduit, you can use a weatherproof LB (line box) or a weatherproof junction box. An LB works well for pulling wire, but no wire connections are allowed inside it. A junction box can contain wire connections, and when fitted with a weatherproof receptacle cover, it can also hold a receptacle. We used an LB at the outbuilding and a junction box with a receptacle at the house.

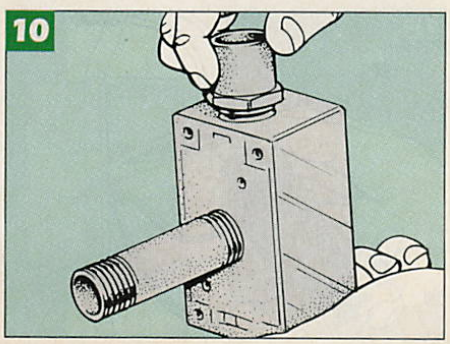
At the outbuilding, bore a hole directly above the conduit, about 40 in. above the floor, or to match the intended height of your receptacles. Cut and join a piece of conduit to the LB and slip coupling so the height of the LB matches the hole. Then, insert a short stub of conduit into the LB's right-angle fitting, without gluing it, and guide the stub through the hole in the wall (Fig. 6). Secure the riser and LB to the siding with a galvanized metal strap.

To determine the final length of the stub, slip a male box adapter over it, again, without gluing the fitting (Fig. 7). Then, remove a knockout from a metal junction box and seat the box over the male adapter. The distance that the front of the junction box extends beyond the face of the nearest stud is the length you'll need to subtract from the stub. After removing the stub and shortening it, glue it to the LB and the male adapter. Press the box over the male adapter and screw the box to the stud, through its side holes. Finally, thread a locknut onto the male adapter and tighten it (Fig. 8).

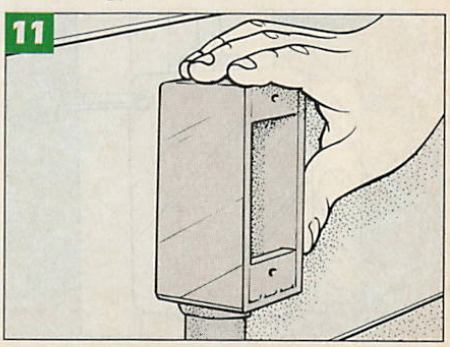
At the house, bore through the rim joist above the conduit (Fig. 9). Install a 4-in. threaded-plastic nipple into the back of the weatherproof junction box and a plastic male adapter into the bottom of the box (Fig. 10). Press the threaded nipple through the wall and screw the box in place. Run conduit to the box (Fig. 11) using another slip coupling, and caulk the joint between the siding and box.



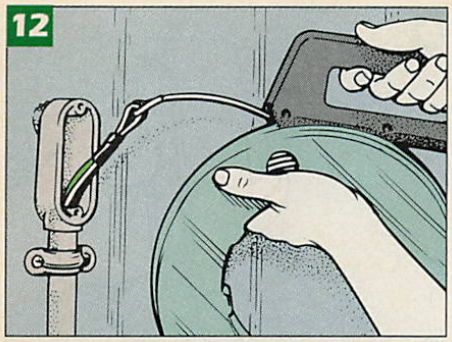
Bore through the house's rim joist at the new junction box's location. Position hole between floor joists.



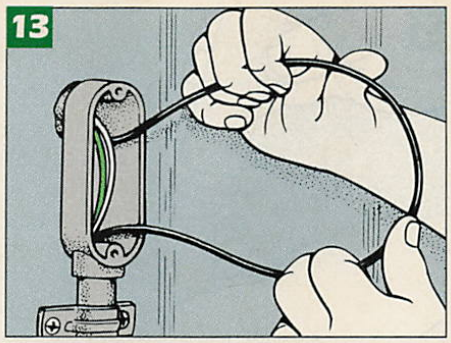
Thread a plastic nipple into the back of the junction box and add a male adapter at the bottom of the box.



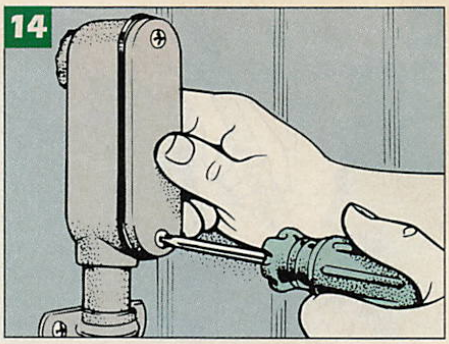
After screwing the box to the siding, finish the conduit run by gluing the riser into the box's male adapter.



Attach 12-ga. wires to end of fish tape and pull through the conduit. Leave 12 to 16 in. exposed at boxes.



Feed the three insulated wires through the back of the LB and into the junction box inside the building.



With the wires tucked into the LB, install the rubber gasket and box cover. Caulk the opening in the siding.

Pulling Wires

Once the conduit is in place, three color-coded wires must be carried through it from the house to the outbuilding. To pull the insulated wires through the conduit, first feed a fish tape from one box to the other. Attach three 12-ga. wires (black, white and green) to the end of the tape and wrap them together with vinyl electrician's tape. Then, slowly pull the wires back through the conduit (Fig. 12). If it's a long run, it helps to lubricate the wires with liquid dish soap. Leave plenty of wire showing at each box. At the LB, carefully feed the wires through the wall (Fig. 13) and fasten the cover plate over its weather gasket (Fig. 14).

Wiring The Outbuilding

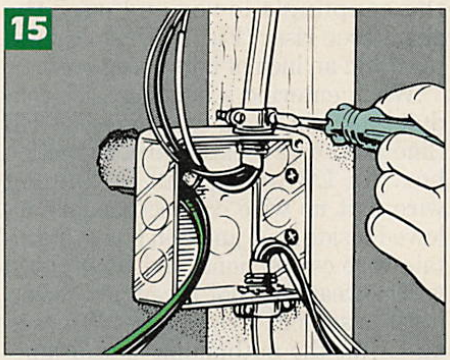
Begin by fitting the junction box with two box connectors—one for the 12/2 w/g (with ground) cable that powers the light, and the other for the cable that leads to the receptacles. Pull 8 in. of each cable into the box and strip the sheathing from both.

Tighten the box connectors (Fig. 15) and strip ½ in. of insulation from each wire. Join like-colored wires in twist connectors and join the green wire from the conduit to the bare cable grounds (Fig. 16). With a metal box, add a length of green wire to connect all three ground wires with the grounding screw at the back of the box. Finish by installing a blank cover plate (Fig. 17).

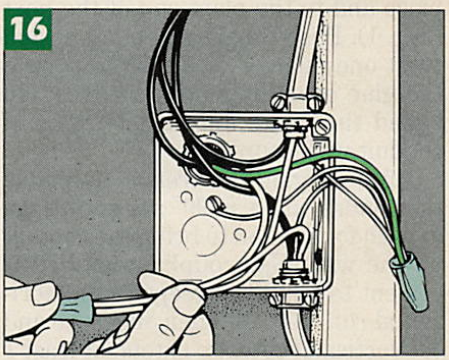
Run the cable in the middle of the stud cavities and joist spaces where it can be protected. Staple cable to structural members every 4 ft. and within 8 in. of each box. If you plan to run cable through holes in studs and joists, bore the holes in the centers of the members. Try for straight, well-secured cable runs that won't be skewered by drywall nails if you someday finish the walls and ceiling. If a cable must run through a hole that's closer than 1 in. from the face of a structural member, or if codes require, nail metal protection plates over the members at these points. And finally, while most localities don't require conduit in unfinished walls, it pays to ask.

To power a single ceiling fixture, first bring the cable from the junction box to a switch box centered 40 in. off the floor. Then, add a second cable to carry power to the fixture. Bore the top wall plates and run the cable into the attic. Continue along a ceiling joist and into a ceiling box, leaving 8 in. of unsheathed wire showing.

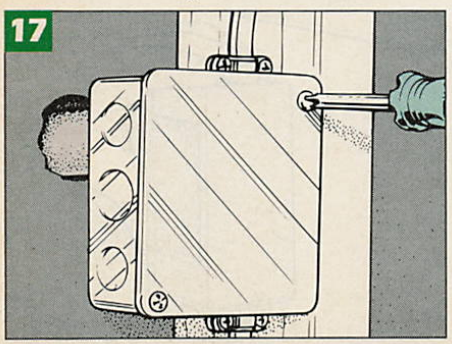
At the switch, join both neutral wires in a twist connector and the ground wires in a second connector. Then attach the two black wires to the switch (Fig. 18) and install the switch in the box. At the ceiling fixture, attach the black wire to the brass-colored terminal and the white wire to the silver terminal (Fig. 19). With a nonmetallic box, press the ground wire deep inside or secure it to the fixture grounding screw if provided.



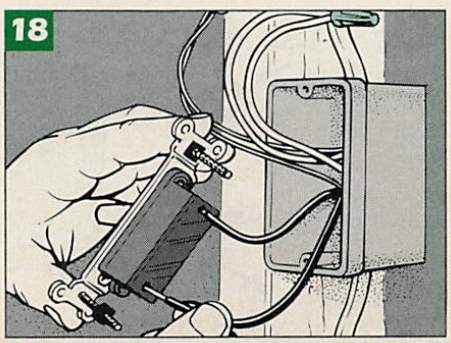
Bring the light and receptacle cables into the junction box through box connectors. Staple cables within 8 in.



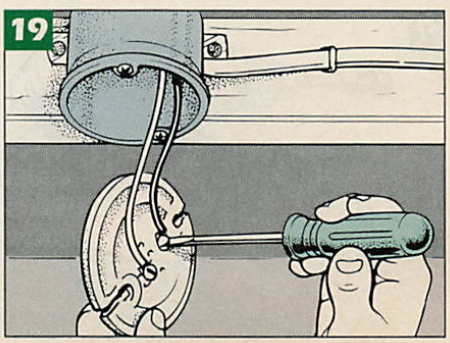
Use twist connectors to join like-colored wires in the junction box. Add a green pigtail to box grounding screw.



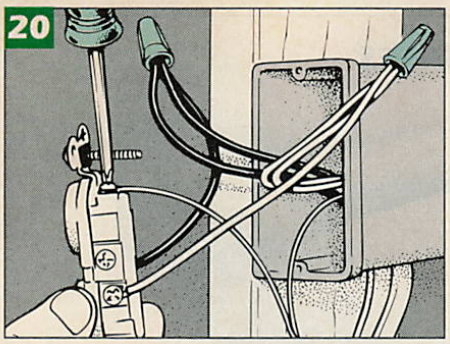
Finish by protecting the wire connections with a cover plate. All junction boxes must remain accessible.



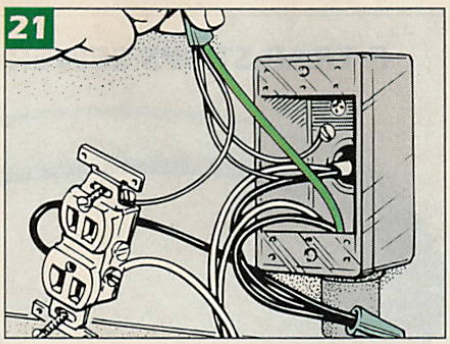
Press black wires into stab-in terminals on switch. Join neutral wires in one connector and grounds in another.



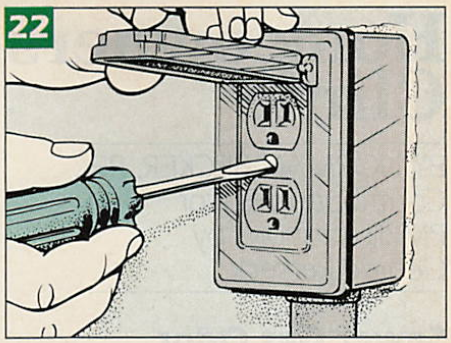
To wire the ceiling fixture, connect black wire to copper-colored terminal and white to silver-colored terminal.



To wire a middle-of-the-run outlet, use pigtails between the receptacle and circuit wires. Ground the receptacle.



Wire outdoor outlet with pigtails—black to copper terminal and white to silver. Ground the receptacle and box.



Finish by installing weatherproof receptacle cover with a rubber gasket between the cover and box.

To wire all receptacles but the last, you'll need to make the connections through pigtails. A pigtail is a short length of color-coded wire with one end connected to a receptacle terminal and the other joined with a like-colored wire from the circuit. In this way, a failed receptacle can't interrupt power to those following it.

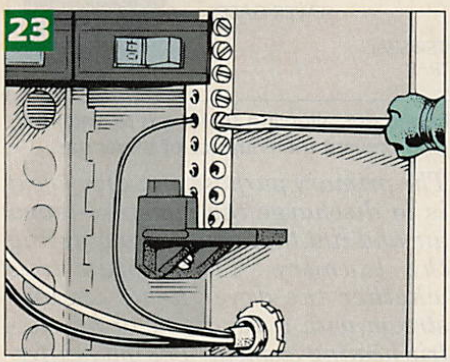
Some codes require pigtails on the hot side only, while others require both hot and neutral pigtails. Ground wires are always pigtailed unless it's the last receptacle. Install the receptacles in the boxes and secure the receptacle covers (Fig. 20).

At the outdoor receptacle located on your house, run cable between the panel and box, using pigtails as described. The only difference is that you'll need to ground the metal junction box as well. Do this with an additional pigtail secured to a grounding screw in the box (Fig. 21). Finally, install a weatherproof receptacle cover and rubber gasket to keep out moisture (Fig. 22).

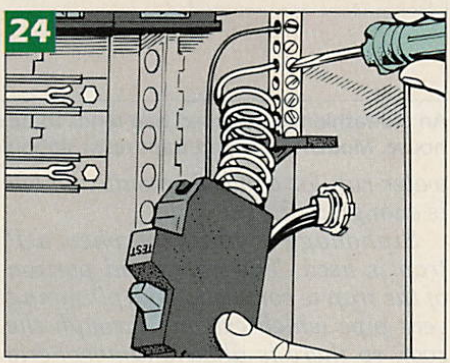
At The Panel

Codes require that any outlet that might be used under wet conditions, including outdoor receptacles and those in outbuildings, have built-in ground-fault protection. The only exceptions are lights and special-use receptacles for appliances such as air conditioners or garage door openers.

The device that provides this protection is called a ground-fault-circuit interrupter (GFCI). It's designed to sense a short circuit by monitoring the current in both hot and neutral wires. If an imbalance occurs, indicating a short circuit, power is switched off. Either a GFCI breaker or a GFCI receptacle can be used depending on the situation. GFCI breakers are a good choice when all outlets should be protected. GFCI receptacles are useful when only one or several outlets on a circuit need protection, while others, such as those for stationary tools and appliances, are better off without it. GFCI receptacles come in two forms—those which provide protection in only one outlet, and those which also protect every outlet following it on a circuit. With the latter type, a circuit can be organized to provide both protected and unprotected outlets.



Join the new circuit's bare ground wire to the neutral bus, or to the ground bus if two buses are provided.

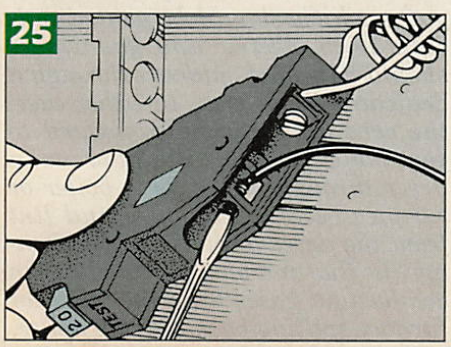


GFCI breaker has its own neutral lead. Secure the breaker's neutral lead wire under a neutral bus lug.

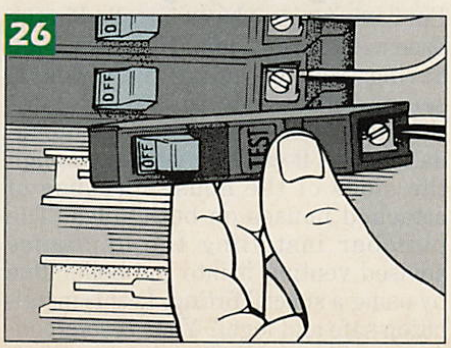
We opted for a GFCI breaker to serve the entire circuit. Unlike standard breakers that have one terminal for the circuit's hot wire, GFCI breakers have two terminals for both the hot and neutral wires. The breaker comes with its own neutral lead that's connected to the breaker panel's neutral bus bar.

Begin wiring the panel by shutting off the main disconnect switch. Then, remove the panel cover and break a ½-in. knockout from the top or side of the panel. Install a box connector and feed cable into the panel. Next, cut the ground wire to length and bind it under one of the lugs (screws) of the neutral bus (Fig. 23), or the grounded bus if a separate one is provided.

Next, bind the end of the GFCI breaker's neutral lead under a separate neutral bus lug (Fig. 24). Follow by connecting the cable's hot (black) wire to its breaker terminal and the neutral (white) wire to its terminal (Fig. 25). Then, press the breaker into its slot on the hot bus bar (Fig. 26) and replace the panel cover. When the circuit checks out, make it a point to check the breaker every month or so. PM



Join the circuit's hot and neutral wires to the breaker's terminal lugs. The neutral lug will be white or silver.



With breaker wired, hook one end under the panel's connecting flange. Press other end over the hot bus tab.

Homeowners Clinic

BY NORMAN BECKER, P.E.,
Contributing Editor
PM Illustrations by
George Retseck

Sewer Gas Odor

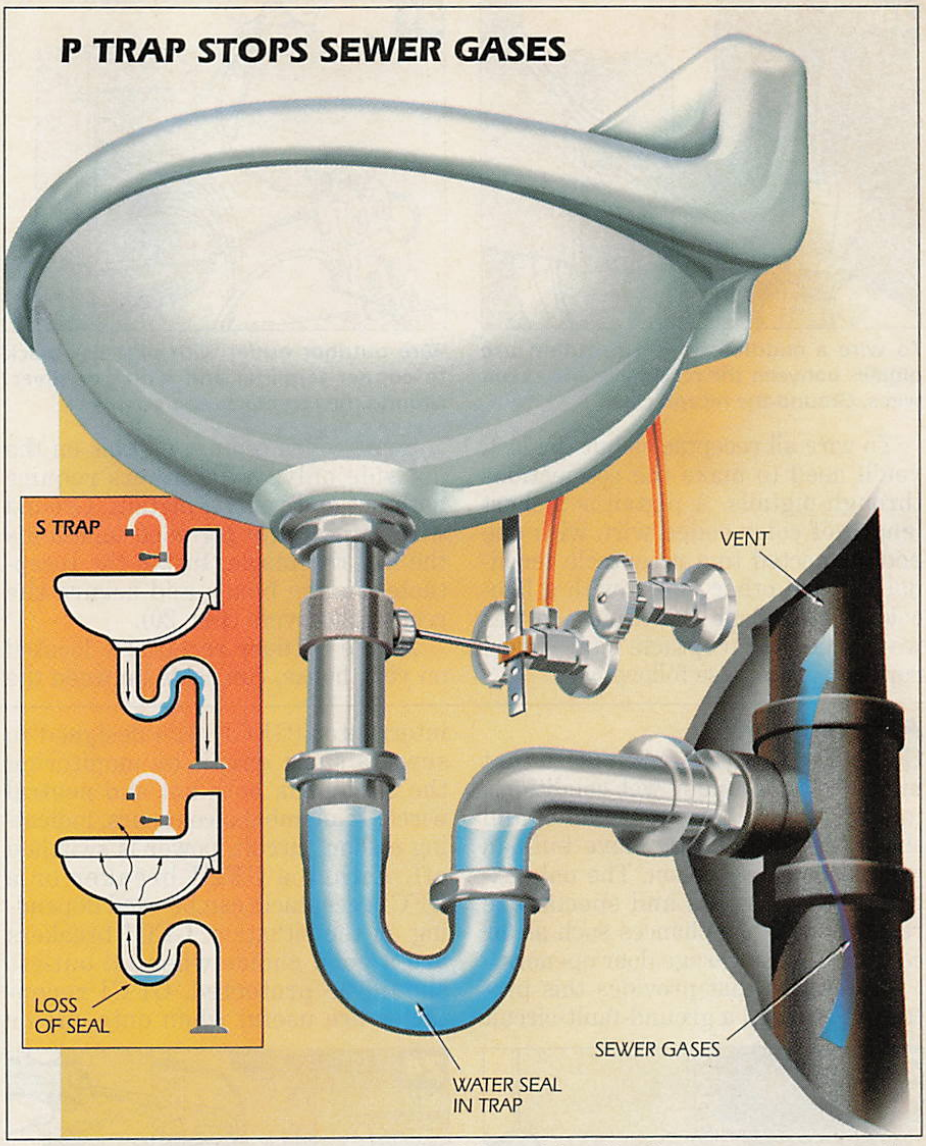
Eight years ago we remodeled our bathroom and installed a vanity sink with faux marble top and no overflow hole. After a while, a terrible odor began building up and getting worse. We replaced the sink top two years ago (this one has the overflow hole) and again the odor is terrible. We've kept the drain clear with drain cleaner, but that doesn't seem to affect the odor. Do you have any ideas about its cause?

GRETCHEN SMALLRIDGE
BUCKHANNON, WV

The problem is not related to the presence or absence of an overflow hole in the sink basin, or the need for a drain cleaning product. Although you didn't mention the type of trap in the drain line, I suspect it is an S-shaped trap rather than a P-shaped trap. The former is commonly called an S trap, the latter a P trap. An S trap could cause the problem you are experiencing. Most municipalities no longer permit the installation of S traps in new construction. However, during my home inspections over the years, I have seen many of them in older houses as well as a few in new homes.

The purpose of a trap under a sink is to prevent the escape of sewer gas into the room. It does this by trapping water in the U-shaped portion of the pipe, forming a water seal. The water blocks the movement of sewer gas and prevents it from flowing up through the trap, the sink drain and into the room.

The problem with an S trap is that the water seal may be lost due to siphonage. In the case of an S trap, the pressure of air on the water in the fixture is greater than the pressure of air in the drainpipe on the down side of the trap. The action of the water discharging into the drainpipe removes the air from that pipe and thereby causes a negative pressure in the drain line, resulting in siphonage of the water from the trap. The water seal is lost and sewer gas can flow into the room. If this should occur, and you smell sewer odors, an easy fix is to open a faucet and let the water run for about 5 seconds, which is enough to fill the trap.



An old-fashioned S-shaped trap tends to be siphoned dry, allowing sewer gas to enter the house. Modern P-shaped traps resist siphoning and prevent the entrance of sewer gas.

Siphonage is unlikely when a P trap is used. The horizontal portion of the trap is connected to a plumbing vent pipe which extends through the roof, so there is always atmospheric pressure on the down side of the trap.

Venting Gas Dryer

I'm having a gas dryer installed in the basement of my home. However, I am having trouble venting the dryer. It seems impossible to run the vent through the house's thick stone foundation, and it can't be vented through the sides of the house, because of attached houses on both sides. The plumber installing the appliance advised venting it into the boiler flue by using a special fitting. Is this installation safe and legal? Your recommendation will be appreciated.

BHAGAVATTI SHAH
HOLLIS, NY

The primary purpose of a dryer vent is to discharge the moisture-laden air and lint that results from drying the laundry. This holds true whether the dryer heats its airstream with a gas flame or an electric heating element. The only difference between the two is that the airstream from a gas dryer will contain small amounts of combustion gases which should be vented outside. Both electric and gas dryers should be vented outdoors through a dedicated metal vent. In either case, the vent must not be connected to your boiler flue. It is illegal to vent a dryer through a flue for a boiler or furnace because moisture and lint from the dryer will eventually damage the flue and block it, resulting in combustion gases from the boiler or furnace spilling back into the house.

At one time, dryer manufacturers sold lint-catcher kits to be attached to dryer vents for indoor venting.

They no longer do so and now recommend venting a dryer to the outside through a dedicated metal vent. Several problems were associated with indoor venting, and among them was the introduction of moisture into the house. Also, people did not clean the lint catcher frequently enough. A lint buildup is a fire hazard and causes the dryer to work inefficiently. Check and clean a dryer vent once a year.

Although it may be difficult, a hole can be made through the rear foundation wall to vent the dryer. You may need the assistance of a mason.

Siding Over Asbestos

We live in an old Victorian house with asbestos siding on it. We want to put vinyl siding on it, but we need to know if it is necessary to remove the asbestos siding first. Siding contractors say they can apply the vinyl over the asbestos, but one contractor warned us that the asbestos siding will crack when the vinyl siding is nailed on top of it, and that pieces of broken asbestos would fall down and accumulate, causing bulges in some areas of the vinyl siding.

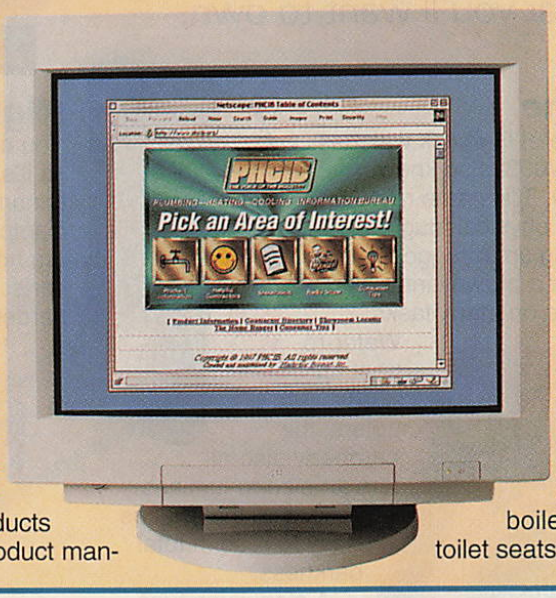
RUTH O'DONNELL
LOWELL, MA

I discussed your situation with the Vinyl Siding Institute, which said that it recommends not disturbing the asbestos shingles. The best practice would be to apply sheathing over the existing asbestos siding and then apply vinyl siding over the top of the sheathing. The sheathing will serve to flatten the walls and will contain any broken asbestos shingles. The vinyl siding should be applied using nails that are long enough to penetrate the sheathing, the asbestos shingles, the sheathing below the shingles and the wall studs.

For information on installing vinyl siding, the Institute offers the manual Rigid Vinyl Siding—Application Instructions. *It is item BG 105 and can be ordered from The Society of the Plastics Industry Inc., P.O. Box 753, Waldorf, MD 20604; 800-541-0736.*

Review: Web Site For Plumbing

● Spend a few minutes the next time you're poking around the Web to get acquainted with the Plumbing-Heating-Cooling Information Bureau's Web site at http://www.phcib.org. As you can see from a photo of its home page (right), the site offers consumer tips, lists of manufacturers, names of contractors, and the names of product showrooms. Obviously, the site promotes the views and products of plumbing product manufacturers and plumbing contractors, so you won't find hardcore how-to-install-it information. You'll find lots of consumer tips, covering things like dealing with frozen or burst pipes, and checklists for the heating or cooling season and costs for remodeling jobs. If you're in a hurry to find a manufacturer, it's certainly worth a stop. You'll find a list of various product categories, from boilers to sinks to toilet seats. *—R.B.*



Plastic Laminate Maintenance

My 30-year-old Formica countertop is in good shape. Although polishing helps to rejuvenate its shine, it makes every fingerprint appear more noticeable than if the laminate had not been polished. What's the best way to maintain the counter's appearance while reducing the tendency of fingerprints to appear as streaks?

MARGARET UHRINEK
READING, PA

Polishing is not required for any laminate surface manufactured by Formica Corp. All that is required for any of the company's laminates is cleaning with a soft cotton cloth and a mild liquid detergent or household cleaner. The surface should be dried with a clean cotton cloth to avoid spotting. If your counter has a high-gloss finish, residual streaks might remain after cleaning. In this case, the company recommends removing streaks with a mild glass cleaner and a soft cotton cloth.

The company publishes a brochure, Use and Care Guidelines, *that discusses cleaning and lists cleaners that will cause chemical damage. It has recommendations on stain removal and how to avoid damage from scratches or impacts. You can obtain the brochure from a Formica dealer or contact the company directly by writing to Marketing Dept., Formica Corp., 10155 Reading Rd., Cincinnati, OH 45421; or call 800-367-6422.* PM

BUZZWORD ○ ○ ○ Block Resistant

● Things have changed in the do-it-yourself world. More professional-caliber products are available to homeowners, and terms that were once unheard of in a do-it-yourself context are becoming commonplace. Take block resistant, for example. Painting contractors are careful to use block-resistant trim enamel on doors and windows. Paint that is block resistant provides a surface that is less likely to stick to another painted surface. On the other hand, paint that is not block resistant will stick to another newly painted surface. You've probably seen a recently painted door stick to the jamb, or a pair of windows stick together. The paint is damaged when the two are pulled apart.

Block resistance is a characteristic of top-quality enamels. Read the paint label to find out whether this characteristic has been formulated into the paint. In most cases, the label makes it clear, but if not, ask the paint counter person for assistance. *—Roy Berendsohn*

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

Great Stuff

From home improvement to outdoors, automotive to electronics, here's the newest gear you'll want to own.

FEBRUARY

Tough Time

Casio's new line of G-shock watches includes the DW003, also known as the hardbody. The name reflects not only a physical toughness for standing up to rugged outdoor use, but a brawny interior that can take on many tasks.

Water-resistant up to 200 meters, the hardbody also offers an electro-luminescent backlite that makes it easy to read in total darkness.

A stopwatch function measures time to 1/100 of a second for the first 60 minutes and 1 second after 60 minutes, and it measures net time, split time and second-place times. The watch's calendar is preprogrammed to the year 2039, and there are countdown, multifunction and hourly alarms.

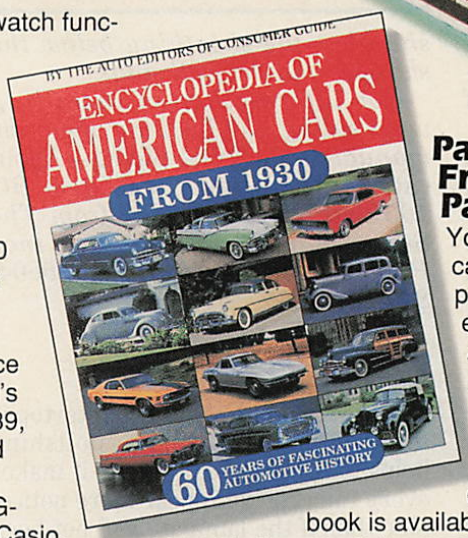
The watch is available at special Casio G-shops across the country for $99. Contact Casio, 570 Mount Pleasant Ave., Dover, NJ 07801; 800-962-2746; www.casio.com.

High-Pressure Job

You need a good set of clamps to join a glued-together assembly so it's straight, flat and square. Jorgensen's deep-reach aluminum bar clamps have 3¾-in.-long jaws for better distribution of clamping force compared with conventional products. The jaws are nonmarring high-impact plastic with heat-treated steel inserts. The clamp screw is made from cold-drawn steel with a hardened steel thrust bearing. The clamps range in length from 12 in. to 72 in. and in price from $38 to $53.

They are sold at hardware stores and home centers. Contact Adjustable Clamp Co., 417 North Ashland Ave., Chicago, IL 60622.

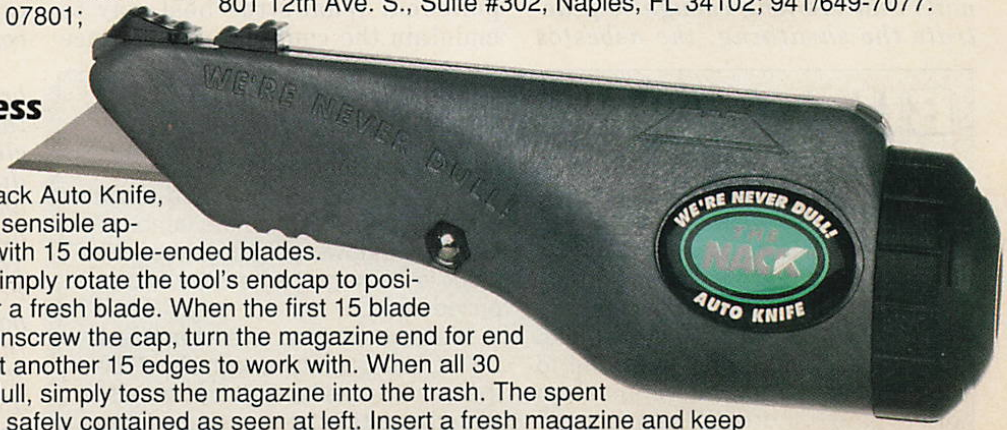
Pages From The Past



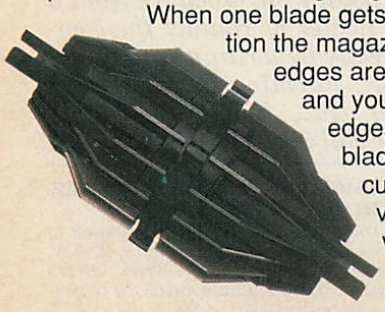
You or your favorite car buff will spend hours poring over this 816-page hardcover edition of the *Encyclopedia of American Cars From 1930*. The book is a comprehensive portrait of the men and machines that made up one of the most fascinating eras of automotive history, and it contains nearly 3000 photos. The book is available for $15 direct from Trident-Cars, 801 12th Ave. S., Suite #302, Naples, FL 34102; 941/649-7077.

A Nack For Inventiveness

A utility knife is one of those devices that people can't help tinkering with, but not always to good effect. The Nack Auto Knife, on the other hand, takes a fresh and sensible approach. It uses a rotating magazine with 15 double-ended blades.

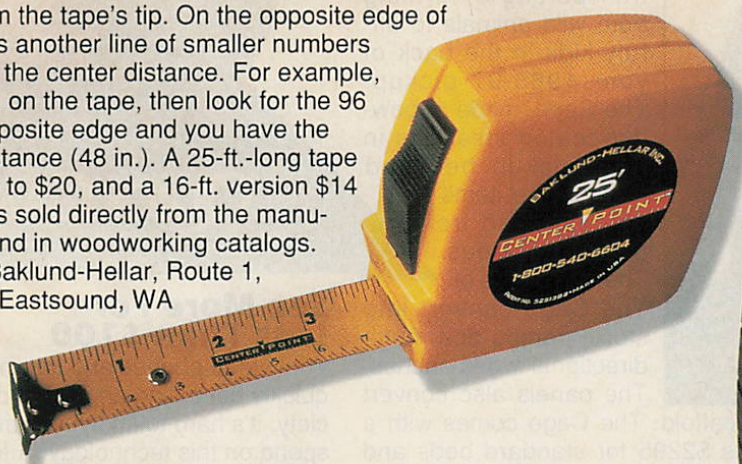


When one blade gets dull, simply rotate the tool's endcap to position the magazine for a fresh blade. When the first 15 blade edges are dull, unscrew the cap, turn the magazine end for end and you've got another 15 edges to work with. When all 30 edges are dull, simply toss the magazine into the trash. The spent blades are safely contained as seen at left. Insert a fresh magazine and keep cutting. The tool uses a sliding thumb latch to move the blade forward and a safety catch prevents child tampering. The prototype that we tried seemed downright remarkable. The plastic version shown costs about $20 at hardware stores and home centers, and a metal version costs about $35. Magazines cost about $6 each. Contact The Nack Co. Ltd., 5515 North Service Rd., Burlington, Ontario, Canada, L7L6G4; 888-862-5536.



Front And Center

The Center Point is a tape measure with a twist. One edge has bold-faced numbers that mark the conventional distance from the tape's tip. On the opposite edge of the tape is another line of smaller numbers that mark the center distance. For example, find 96 in. on the tape, then look for the 96 on the opposite edge and you have the center distance (48 in.). A 25-ft.-long tape costs $15 to $20, and a 16-ft. version $14 to $18. It's sold directly from the manufacturer and in woodworking catalogs. Contact Baklund-Hellar, Route 1, Box 623, Eastsound, WA 98245.



Build A Valentine

Gourmet In A Box is the cooking equivalent of a kit car, and it allows any do-it-yourselfer to perform one of the most romantic acts known to man—cooking your loved one a sumptuous gourmet meal.

The three entrees—herbed pasta, apricot-garlic chicken and baked eggplant—comprise three courses and come with sauces, herbs and premeasured ingredients.You just follow the simple 10-step directions, and—*voilá*—you're a combination of Brad Pitt and Julia Child.

The kits cost about $24 each and the additional food items should run no more than $15. Order by phone: 800-224-4404.

Great To Be Silver

Your nostalgia ride, cruiser or hot rod won't look cool unless it's wearing the right tires. New BFGoodrich Silvertown Radials capture the nostalgia look of a wide whitewall, adding modern tire technology. Featuring steel belts and V-block tread design, the Silvertowns come in seven sizes ranging from 215/70R14 to 255/70R15 in whitewall widths up to 3 in. You'll pay between $150 and $180 for the tires from Coker Tire, 1317 Chestnut St., Chattanooga, TN 37402; 800-251-6336.

German Deuce

BMW has just rolled out its latest performance vehicle—the Dynamic Mountain Bike. The bike aims to combine high performance with take-it-along convenience; it features a 21-speed drivetrain and folds up small enough to fit in almost any trunk.

Quality Shimano components, including a 170mm alloy crankarm, 21-speed hyperdrive-C gearing and STX brakes combine with an RST suspension fork and an internally welded 4130 chromoly frame to give the new bike a performance edge. To fold the bike down to a compact 3 × 3 × 1 ft., you simply remove the front wheel, unlock two quick-release levers and swing the front half of the frame around. It takes less than a minute. The bike has a suggested retail price of $695 and is available at BMW dealers across North America. Contact BMW of North America, Box 1227, Westwood, NJ 07675; 201/307-3785; fax: 201/573-8416.

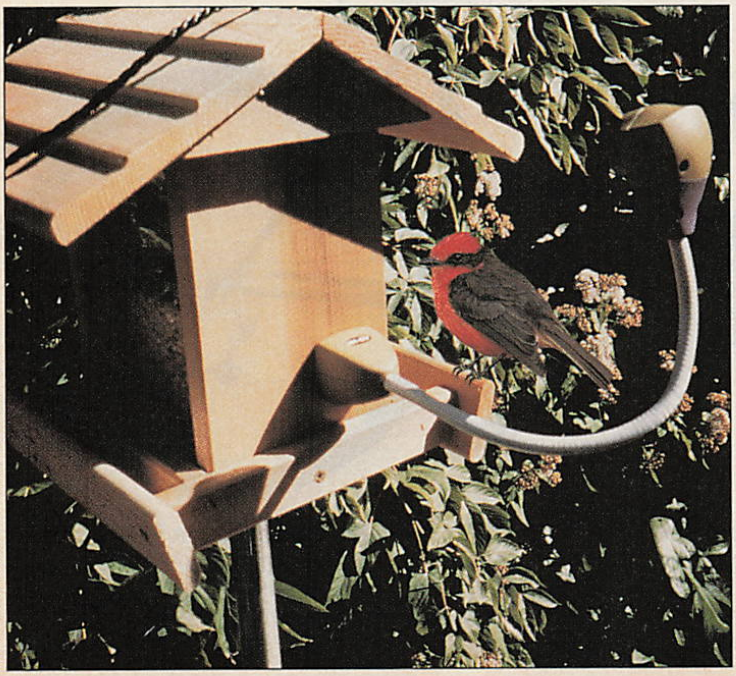
Behind Bars

Here's a great item for transporting everything from wild animals to unruly kids in the back of your 1988-97 pickup. The Cage, made of powder-coated steel, fits in your pickup bed and locks in the items that you can load from the top or sides. The top panels of The Cage convert into sturdy ramps and multi-directional workbenches. The panels also convert into a free-standing worktable, bench or mini-scaffold. The Cage comes with a windowed snap-on waterproof cover and costs $2295 for standard beds and $2395 for long beds. For more information, contact The Cage, 2214½ North Ave., Chico, CA 95926; 800-400-9151.

Outside Shoot

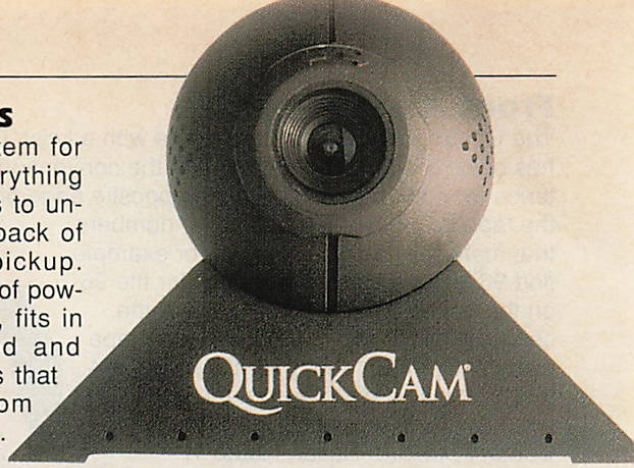
At one time or another, we've all wished that the great outdoors came with its own built-in video camera. Nature provides some of our most beautiful, precious, and even comical material, yet we're not always around to catch all the action on our handheld video cameras.

Video Research, a Minnesota-based company, recently introduced a new idea for sportsmen and outdoor types who don't want to miss a thing. The new SportsCam color video unit includes a miniature high-resolution video camera and high-gain microphone—both of which supply live audio and video directly to your VCR and TV monitors. The camera is weather-resistant and it mounts at the end of a 12-in. flexible goose-neck which can be attached to different types of wildlife habitats, bird feeders or nesting areas.



INTERNATIONAL STOCK/MARK NEWMAN PHOTO (BIRD)

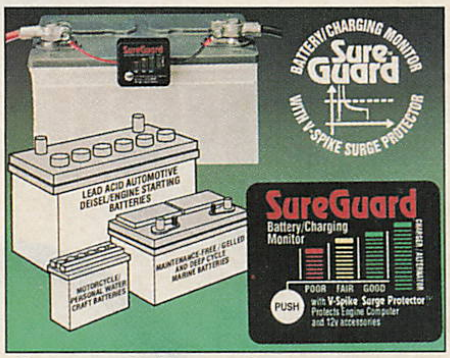
The SportsCam includes CCD camera elements with electronic iris control and automatic white balance to help adapt to different lighting conditions. The retail price for this camera is $495. Contact Video Research, 2010 E. Hennepin Ave., Minneapolis, MN 55413; 612/378-2577.



See More For Less Than $100

With video phones and Internet video quickly becoming an aspect of our society, it's hard to know how much to spend on this technology. A few manufacturers are offering full video phone systems which attach directly to your TV at prices beginning in the $400 to $500 range. And even though this technology is better than any of its type we've ever seen, it's still not quite up to par for real-time video.

So why spend tons of money for something that should get better in the future? Try the Connectix QuickCam VC. Although you can't use it on your phone—you can communicate visually through the Internet, modem-to-modem, or with still images and video clips attached to e-mail. The VC costs $99 and includes frame rates over 15 frames per second over a Universal Serial Bus or parallel ports. No internal cards are needed to install the camera. It's a low-cost way to try this futuristic communication rage.



Current Events

Is your battery bad, or is your charging system getting lazy? The SureGuard can give you the answer. Attach the device to your battery, and four color-coded LEDs tell you the state of your battery and whether your alternator and regulator are doing their jobs. The unit also protects your electrical and electronics systems against the voltage surge of jumpstarts and helps avoid unnecessary replacement of good batteries or electrical components. The SureGuard works with any 12v system and costs $29.95 from VDC Electronics Inc., P.O. Box 5537, Englewood, NJ 07631; 800-379-5579.

(More New Products on page 108)

Don't Buy a Big Tiller

For a Small Job!

If your garden is an acre or more, you may want to buy a big tiller. If it's any less, you should buy a Mantis Tiller/Cultivator. Big tillers till and weed 20" or more wide. The Mantis Tiller/Cultivator tills and weeds a practical 6" or 9" wide.

Big tillers weigh almost 300 lbs. The Mantis tiller weighs just 20 lbs.! Simply turning a 300 lb. tiller in a backyard garden without running over crops (or yourself) is a challenge.

Costs Hundreds Less!

Most big tillers were designed to just till (but many now offer clumsy "add-on" attachments to try to justify their high cost). The Mantis Tiller/Cultivator was designed from the beginning to precisely match a small, powerful engine to a variety of useful attachments for your yard and garden. Tiller. Cultivator. Furrower. Edger. Lawn Aerator. Lawn Dethatcher. Hedge Trimmer.

Most big tillers cost an arm and a leg. Despite the fact that the Mantis is a tough, durable, precision instrument...it costs a *fraction* of what you'll pay for a big tiller.

Look at the warranty.

Most machines are *partially* covered for 90 days to a year. The Mantis Tiller/Cultivator's patented tines are guaranteed *forever against breakage.* If they ever break, return the broken one to us for a replacement. The *tiller is guaranteed for two years, from the date of purchase, against defects in materials or workmanship.*

If we didn't make such a fine machine, we couldn't make such a fine offer.

- **Easily weeds an average garden in 20 minutes.**
- **Does so many jobs**...from lawn care to weeding...and more!
- **Women and senior gardeners love the Mantis Tiller/Cultivator.**
- **Early order bonus** (if you hurry).
- **Patented tines guaranteed forever against breakage.**

Mantis tines spin at 240 RPM

The Mantis Promise
Try any product that you buy directly from Mantis with NO RISK! If you're not completely satisfied, send it back to us within one year for a complete no hassle refund.

Fun to Use! The Mantis Tiller/Cultivator is so much fun to use-gardeners everywhere love their Mantis tillers.

For free details call toll-free 1-800-366-6268 or mail coupon today!

We Make Gardening Easier.®

FREE Border Edger with Early Orders

Mantis
1028 Street Road
Dept MT1185
Southampton, PA 18966

✔ **Please send more information on the Mantis Tiller/Cultivator.**

Name _____

Address _____

City _____

State _____ Zip _____

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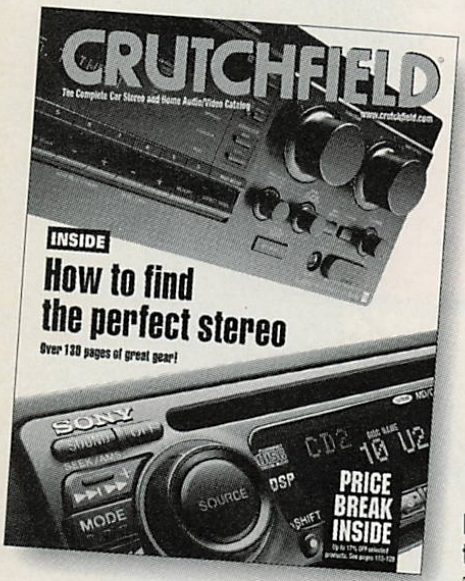

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Bendable Bathware

This product has six settings, so you get to choose the shower you want, and its 15-in.-long bendable arm lets you place the head to suit your height or position the head where needed, such as behind a sore shoulder. How's that for flexibility? It delivers 2800 pulses per minute on the pulse setting, and it's designed to deliver a satisfying amount of flow, even in households with low water pressure. It costs about $50 at hardware stores and home centers. Contact Teledyne Water Pik, 1730 E. Prospect Rd., Fort Collins, CO 80553. PM

NEW PRODUCTS

(Continued from page 104)

Physical Therapy

Picture this: You've just finished the backbreaking job of shoveling out your driveway or wrestling your snowthrower through waist-high snowdrifts. How about a nice, warm massage? Sound good? Kohler thinks so. It developed a massage whirlpool with 10 back jets and two neck jets concealed in a Lycra-covered pillow. The adjustable jets work in sequence to deliver a massage along and across your back, shoulders and neck, much like that delivered manually by physical therapists. The company even consulted massage therapists to develop the product. The 24-in.-deep tub has armrests, footrests and grip rails. The tub measures 42 in. across and 72 in. long. What does all this therapeutic splendor bubble up to? About $6100 to $6800 at Kohler showrooms and kitchen and bath dealers. Contact Kohler Co., Kohler, WI 53044; 800-456-4537.

CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

It's A Clean Machine

My mechanic says I shouldn't clean my engine, that it'll run just fine under that ugly layer of crud. But I think it'll run cooler if I clean it off.

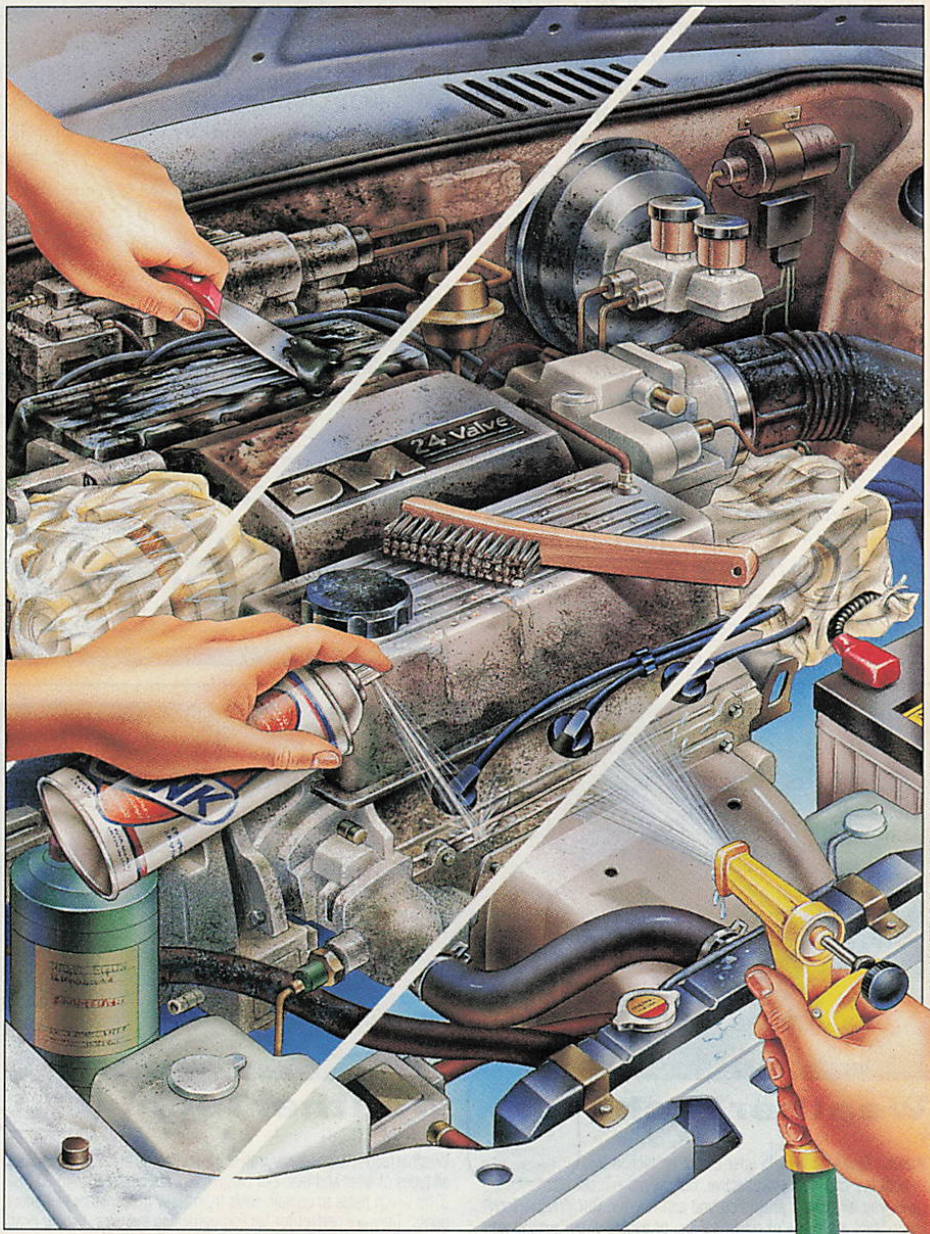
JOHN HOPKINS
BOISE, ID

I'm with you, John. I like a clean engine compartment because it's a lot easier to work on things, and easier to trace minor leaks. The aesthetics count, too.

It is, however, actually illegal to clean your engine in some parts of the country, at least without catching the runoff and disposing of it correctly. Don't even open the hood at a coin-op carwash in California or you'll get a ticket.

Speaking of high-pressure washes, modern cars have a myriad of low-voltage connections underhood, leading from sensors and actuators to the engine computer. Although generally they are adequately protected from normal water intrusion, one blast from the high-pressure wand will blast filth into places it's not supposed to go.

So, if it's allowed at all, I recommend a more labor-intensive approach to cleaning your engine bay. Use a putty knife or screwdriver to mechanically remove as much grunge as possible. Sweep this up and dispose of it appropriately. Identify the electrical connections you don't want to get wet, and move or cover them. Cover the ignition and alternator with plastic. Now it's safe to use engine cleaner, followed by rinsing with a garden hose and hot water. I'd suggest using water sparingly, then letting the puddle dry in the sun. Apply a generous amount of oil dry to the residue and dispose of it appropriately.



PM ILLUSTRATION BY DON MANNES

Almost Halfway

I recently changed my antifreeze per your Oct. '97 issue's article "Flushing Your Cooling System." But what I did was different than your instructions. I just mixed water and antifreeze 50/50 ahead of time and added this mixture to the radiator, ensuring the correct proportions.

TOM SCOTT
VALLEY STREAM, NY

That won't work, Tom. The article directed you to look up the cooling system's capacity in quarts (from the owner's manual) and add half that amount of fresh, undiluted antifreeze. Then top off with water. A quart or two of water is always left in the system after a flush. If you add 50/50 mix straight away, you'll have a more dilute solution and less protection. Check your radiator with a hydrometer and I'll bet you have less than 50% antifreeze.

Fluid Drive

The GM dealer in the area recommends that the brake fluid be changed every two years and the transmission fluid every 30,000 miles. A local garage owner says brake fluid doesn't need to be changed regularly. He also says ATF needs to be changed only if it changes color or

smells burned, and that you only can change a few quarts anyway.

CHAS KURTZ
EL CAJON, CA

I'm siding with the dealer on this one, Chas.

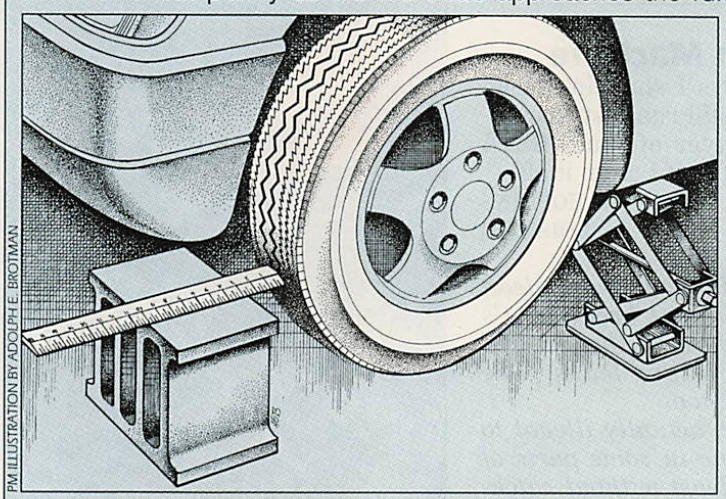
Brake fluid is hygroscopic—it absorbs moisture from the air, which lowers its boiling point and provides an opportunity for corrosion to start inside your braking system. Also, there's a certain amount of particulate matter, such as airborne dust and rubber seal fragments, that collects inside the system. Flushing the system regularly removes these contaminants. If you do this, you'll be less likely to boil your brake fluid on a long downhill stretch, and the seals won't wear out as soon.

As noted, ATF also picks up particulates. In this case it's mostly wear particles from the bearings, gears and clutch packs. The ATF also oxidizes and gains in viscosity. Yes, many car manufacturers say that ATF doesn't need to be replaced for the life of the vehicle. I think your transmission will last longer if you replace most of the fluid every couple of years or so.

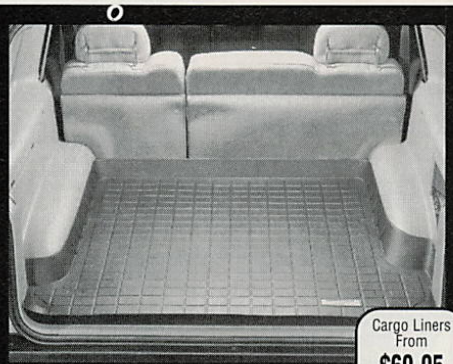
The Golden Rule

CAR CARE TIP

● Tire runout can make your car shake and vibrate even if the tire is perfectly balanced. Actually, a perfect tire can be forced out-of-round if it's mounted on an out-of-round rim, or if the rim is mounted off-center on the hub. Tire dealerships have neat dial-indicator gadgets to measure out-of-roundness, but I've never found I needed them. Jack the car up until the wheel clears the ground. An ordinary ruler, broomstick or even a piece of scrap wood propped on a box or crate makes a good indicator. Set it up so it's just clearing the tread, and spin the tire slowly. You'll be able to see the runout plainly as the tire tread approaches the ruler and then recedes. Mark the high spot, then remount the wheel on the hub. If the runout is less, that's good. But if it's not, then try rotating the tire on the rim 180°. Most of the time, you can reduce runout to negligible amounts easily this way.



PM ILLUSTRATION BY ADOLPH E. BROTMAN



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Mickey's Back

Mice have found a way to get into and out of my '94 Suburban. We regularly find mouse droppings inside the truck. We've set traps and caught several of them. My husband and I have looked high and low and we can't find the point of entry. Any ideas?

ANONYMOUS

Mice can get into any aperture no larger than their tiny skulls, and seem to find cars nice places to make nests and raise a family. If they haven't chewed their way in past a rubber door gasket, I'll wager they are getting in through the HVAC system. Try this—blow some talcum powder on the cowl surrounding the air intake grille. Bet you'll see tiny footprints. If so, you can try adding some screening to the inside of the grille.

If you can stand the smell, placing moth crystals inside the truck should drive them away. Put the crystals in a cloth bag, and remove them when you need to drive anywhere. It will smell bad for a minute or two, but the odor will dissipate rapidly. After the mice have vacated, use the crystals every week or two to keep them away.

Ride Hard, Ride Fast

I have a Dodge Caravan and for years I've been using the original size 195/75R14 tires. I am wondering if it would improve the ride if I replaced them with 195/70 tires. Most vehicles today have 70-series or even 60-series tires, and I thought these would help.

HOWDY BEASOCK
VIA INTERNET

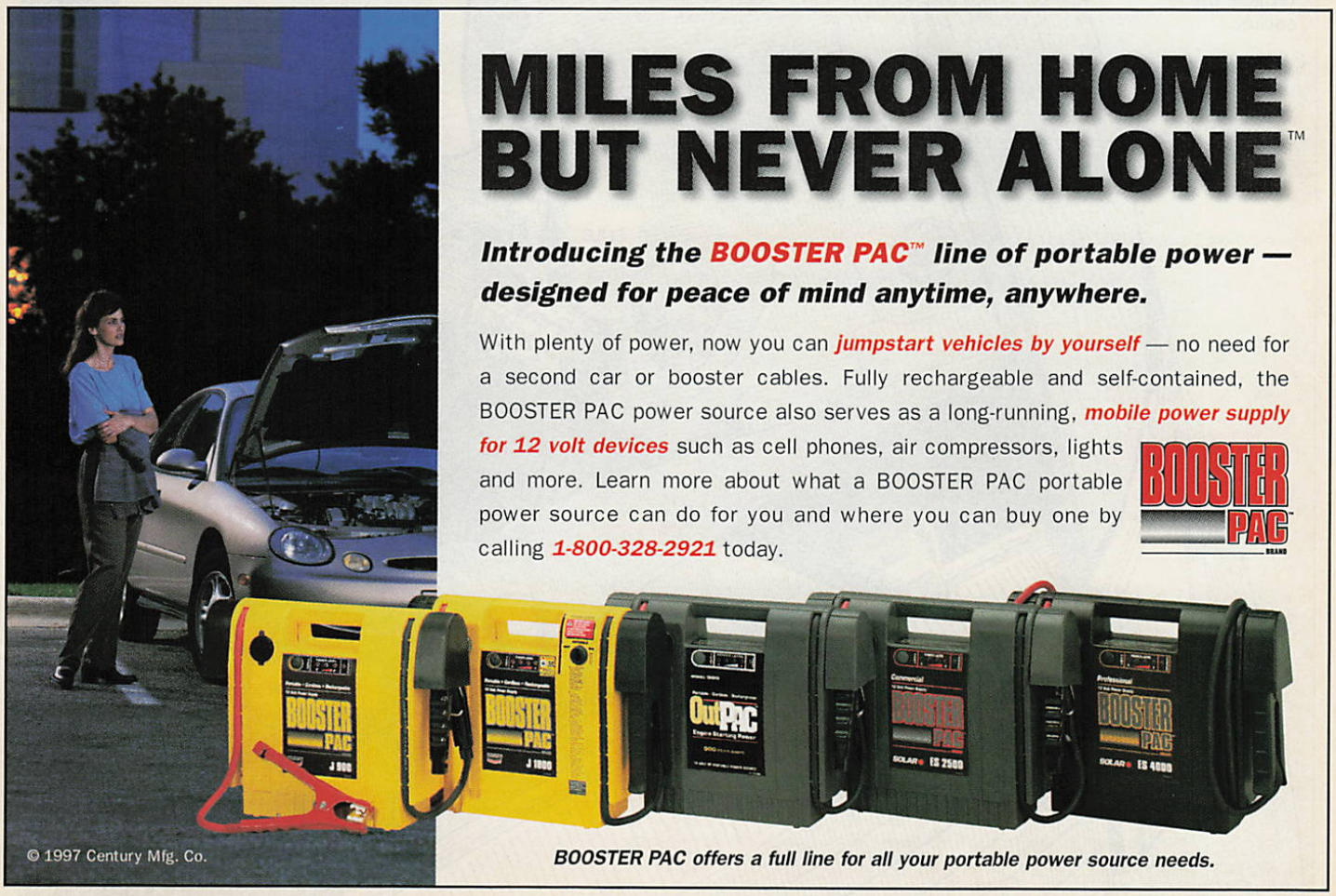
Stick with the 75-series tires you're using, Howdy. It's 75% as tall as it is wide. A 60-series tire is only 60% as wide, has a shorter sidewall and makes the vehicle sit lower. The taller the tire, the more sidewall compliance and the better the ride. At least in theory—different brands and constructions of tires ride differently, and some are optimized for ride more than handling. Maybe it's time to replace some suspension components, like shocks, ball joints and tie rods, to restore your Caravan's original ride. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

SERVICE TIPS

- Several emissions control components may be needed on a 1994-97 gas-engine Dodge Ram pickup that idles rough, gives off fuel odors and turns on the malfunction indicator light.
- The rear suspension bottoms in the cold on some 1995-96 Chevy and GMC 4x4 4-door trucks built prior to VINs TJ347233 and TJ719094, respectively. More resilient jounce bumpers (PN 15023225) have been developed.
- Just about all 1995-96 Ford vehicles built from Nov. 1, 1994, to March 30, 1996, may develop long crank times and stalling after a hot soak. A revised idle air control valve is the ticket.
- All 1992 and newer Audis with the 2.8-liter V6 make a rasping noise at the tailpipe during warmup. This is to extract condensation and is normal.
- A loose power antenna ground in the trunk of your Infiniti I30 (all years) may be all that stands between you and strong static- and hum-free AM/FM radio reception.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SATURDAY MECHANIC

REPLACING HEADLIGHTS

BY PAUL WEISSLER

DEGREE OF DIFFICULTY
EASY

● You're cruising down a 2-lane road late at night. Oncoming cars flash their lights and toot their horns at you. Or they come straight at you and suddenly veer away. No, they're not partied out. Unless you're blinding them with your high beams, one of your headlamps probably is out.

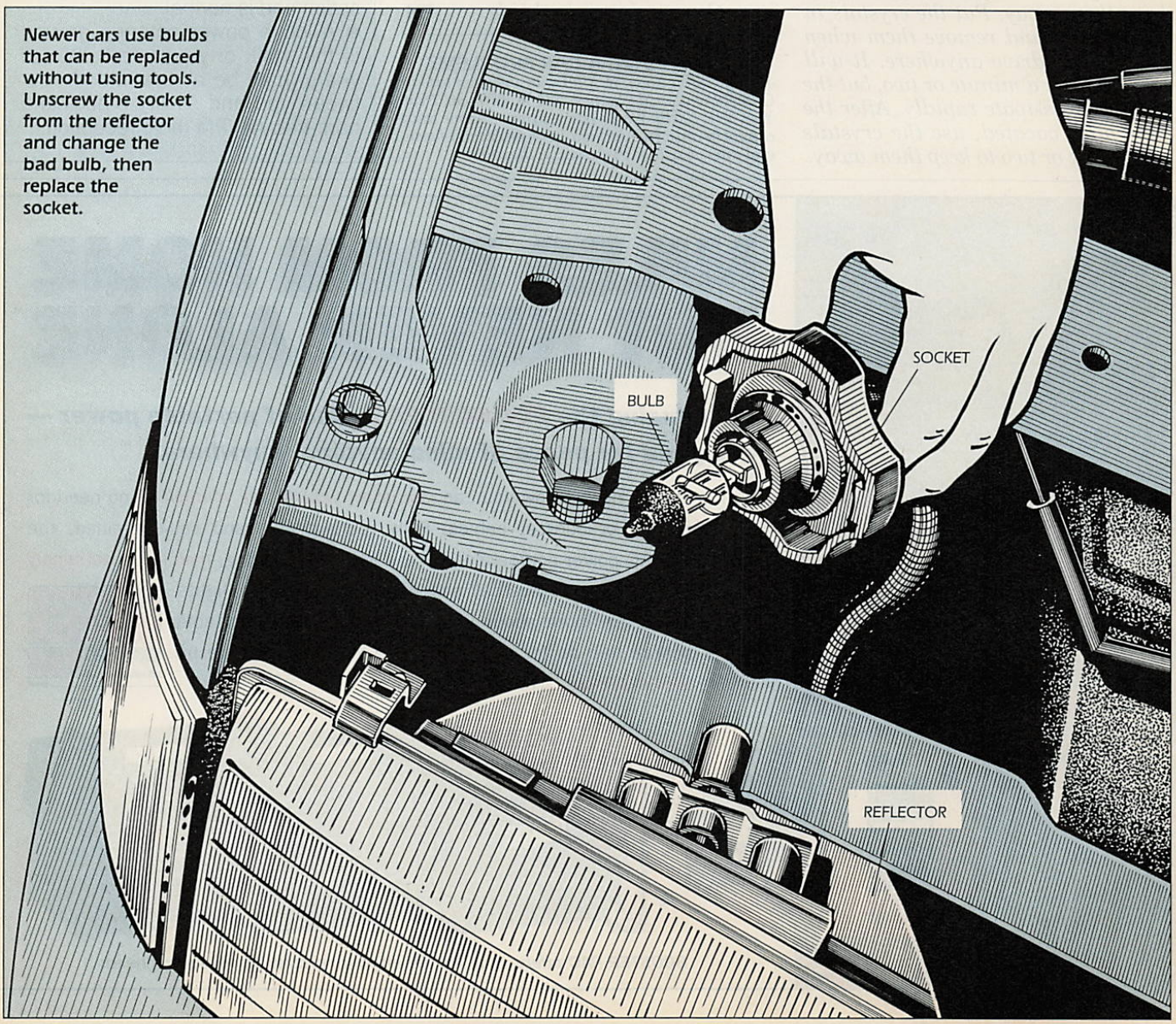
Replacing burned-out headlamps is a straightforward procedure, if the problem is just the headlamp. Although most are about $10, some headlamps are special numbers, available only from a dealer and can cost up to $35 apiece, even for an econobox. And even higher-tech (and higher-priced) systems, such as High Intensity Discharge (HID) headlamps, have just been introduced in a few luxury models. They may look like ordinary headlamps—just as halogen sealed beams resemble the conventional sealed beams used years ago—but the manufacturing processes, the coatings, the materials and the gases used inside the bulbs are totally different and produce totally different lighting.

Don't leave in a headlamp with a cracked lens just because the light hasn't gone out. Even if only a small part of the lens is missing, dirt gets in and coats the bulb inside, which reduces light output. And if there's a chunk missing from the lens, the light beam isn't diffused as it should be and can blind oncoming drivers. With normal vehicle vibration, the lamp also may not hold its aim and you won't get the best view of the road.

Circuit check

If it seems that a headlamp is burned out, make a simple circuit check. With just one of two or four on the blink, the odds are that the sealed beam is the problem. It's unlikely that two headlamps will go out simultaneously.

Of course, if the low and the high beams are in a single bulb, it is possible, but it's much less likely when they're separate lights.



Newer cars use bulbs that can be replaced without using tools. Unscrew the socket from the reflector and change the bad bulb, then replace the socket.

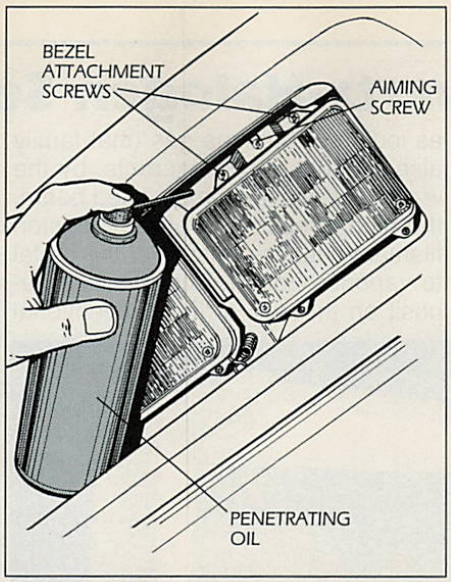
PM ILLUSTRATION BY RUSSELL J. VON SAUERS

Checking or changing a burned-out headlamp begins with gaining access. If it's a sealed beam, there's probably a trim plate in front, which comes off first. Most trim plates are held by either Phillips or Torx external screws. A few may be on studs that project through to the back of the lamp assembly—these are accessible from under the hood.

Next, look for and remove the four screws holding the headlamp rim or bezel. Be careful not to confuse them with the screws that control headlamp aim—the ones with coil springs under the screwheads. Are the screws rust-frozen in place? Don't try too hard to turn them, or you may strip out the screwheads. Spray them with penetrating solvent and allow it to soak in. The attachment screws usually have a Phillips head, but—like the trim screws—they may be Torx.

Once the rim is out, pull the sealed beam forward and unplug the wiring connector from the back. You'll see two or three terminals on the lamp and connector. A 2-headlamp system always has three terminals. A 4-eye lamp may have two or three, depending on how the entire circuit is wired.

A simple check of the circuit is to see if there's power at the connector and a complete electrical ground. Take an ordinary 12v test light, connect the alligator clip end to a ground and check each connector terminal with the probe. The headlamps should be turned on. The test light should go on in at least one terminal. If the sealed beam is a 2-eye with three terminals, flick on the high-beam switch and the test light should go on with the probe in a second one of the three terminals.



If the trim bezel screws are hard to turn, use penetrant to loosen the threads.

Next, unground the test light and gently press the alligator clip end (with a nail inserted, if necessary) to make contact with the other (ground wire) terminal—ground is usually a black wire. The test light should go on again.

If the test light goes on during these two checks, install the new sealed beam. If it doesn't, forget the installation until the circuit problem is repaired. If the test light went on when the alligator clip was connected to ground, but not when you probed the other connector terminal for a complete ground, the problem is a defective ground connection—a common problem.

Check a factory manual—or the POPULAR MECHANICS CD-ROM—for the location of your car's ground. If the connection is corroded, wire-brush it clean. If it's loose, retighten it.

No power to the headlamp connector? That can be more difficult to trace, and you'll need a wiring diagram and parts locator again.

A new circuit complication is on the scene: daytime running lights, or DRLs. These may be the low-beam or high-beam headlamps, or other external lights such as turn signals.

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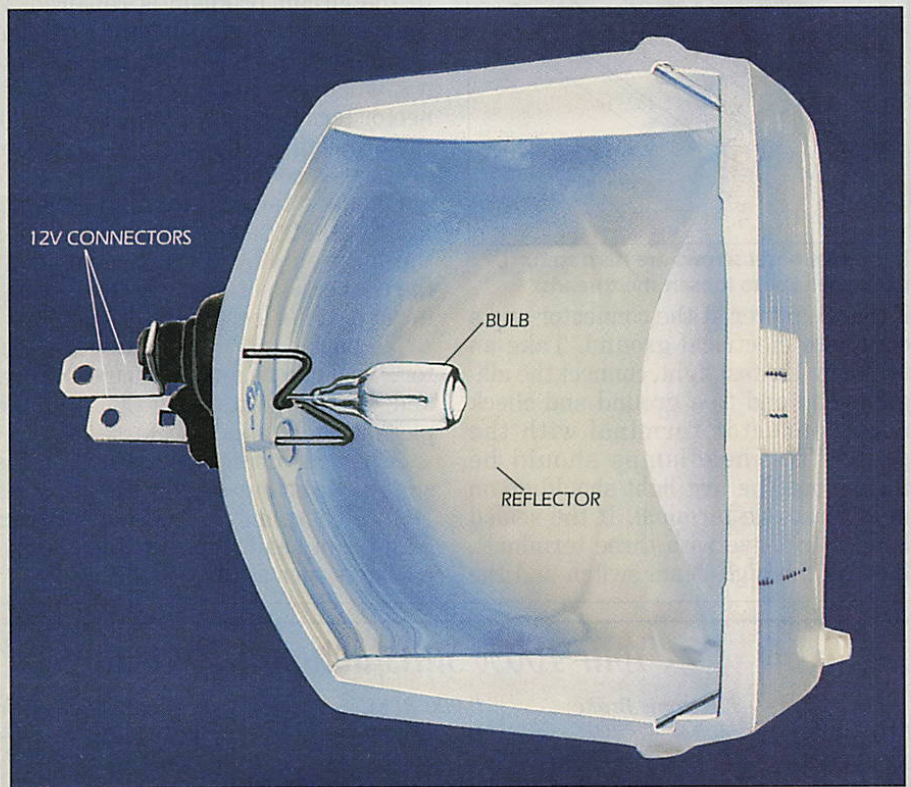
How It Works: Quartz-Halogen Sealed Beam

● The conventional sealed beam of years ago had a tungsten filament inside a lens assembly with a reflector. Today's quartz-halogen beam is a separate bulb inside that lens assembly. It produces a brighter, whiter light—at least 25% more down-the-road visibility, with less power draw.



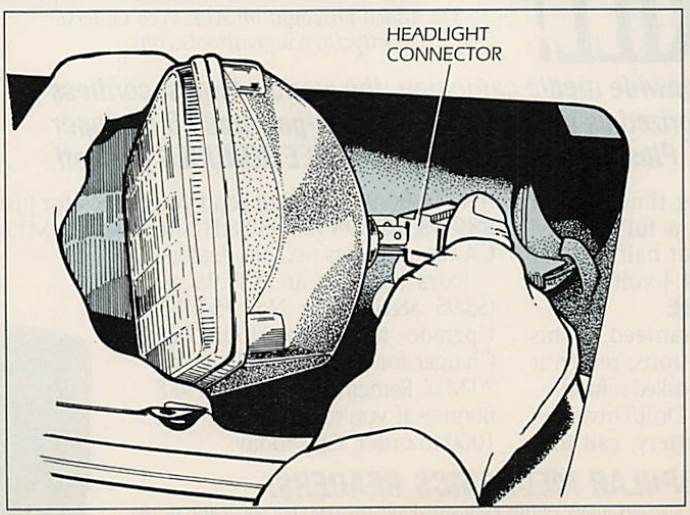
The bulb envelope is a high-temperature glass—the "quartz." The filament material is the familiar tungsten, but the bulb is filled with a special gas from a "family" called halogens, such as iodine or bromine gas (that family also includes a/c refrigerants, by the way). In a conventional sealed beam, the high temperature of the tungsten filament causes particles of the metal to vaporize from it. The particles deposit on the wall of the conventional sealed beam (darkening it), and eventually the filament burns out.

The quartz lens allows the bulb to operate at a much higher temperature to help produce that brighter, whiter light. The halogen gas inside the quartz envelope causes the "evaporating" tungsten particles to continuously redeposit on the filament, so it enjoys long life and consistent brightness virtually until it fails.

Headlamp technology is fast-moving. The High Intensity Discharge lamp is just one of the new approaches, but it's already installed as a low beam in some BMWs and Mercedes-Benzes and the Lincoln Mark VIII. This type has no filament, but instead it has two electrodes in an "atmosphere" of xenon gas. The current jumps the gap between the electrodes, producing a comparatively brighter light. You may have already seen these lights coming at you out on the highway. They're so white that they appear a little blue. But because there's no filament to burn out, the hour life of the xenon bulb is expected to go into six figures.

There are several other new headlamp designs on the market, including one on the '97 Lexus ES 300 that uses multiple reflectors. All the new lamps—including the high-performance halogens—are capable of producing a lot of brightness with reasonable power consumption. And on the near horizon are "smart" headlight systems that use signals from sensors to produce changes in lighting patterns for the road conditions and the way you're driving the car. These combination bright/smart lights are in part a technological fix for the declining night vision of a graying population.

Headlamps are wired in what is called a parallel circuit—each lamp receives full battery voltage. However, if your car is a newer-than-'96 model with daytime running lights and the headlamp high beams are used, there's a second circuit controlling them through an electronic module. The high beams could be wired to the module so that they can be fed current for DRLs in a series circuit—the current flows through both, so that one acts as a resistor for the other. The result is less brightness, but also less current flow for reduced power consumption. If you have a problem with the high beams, a defective DRL module is one of the new possibilities of which you should be aware, both for sealed beams and replaceable bulb designs. Some cars have DRLs that are also designed to shut off when the parking brake is applied. Read those circuits carefully!



Sealed-beam lamps generally have this simple spade-lug triple-blade connector.

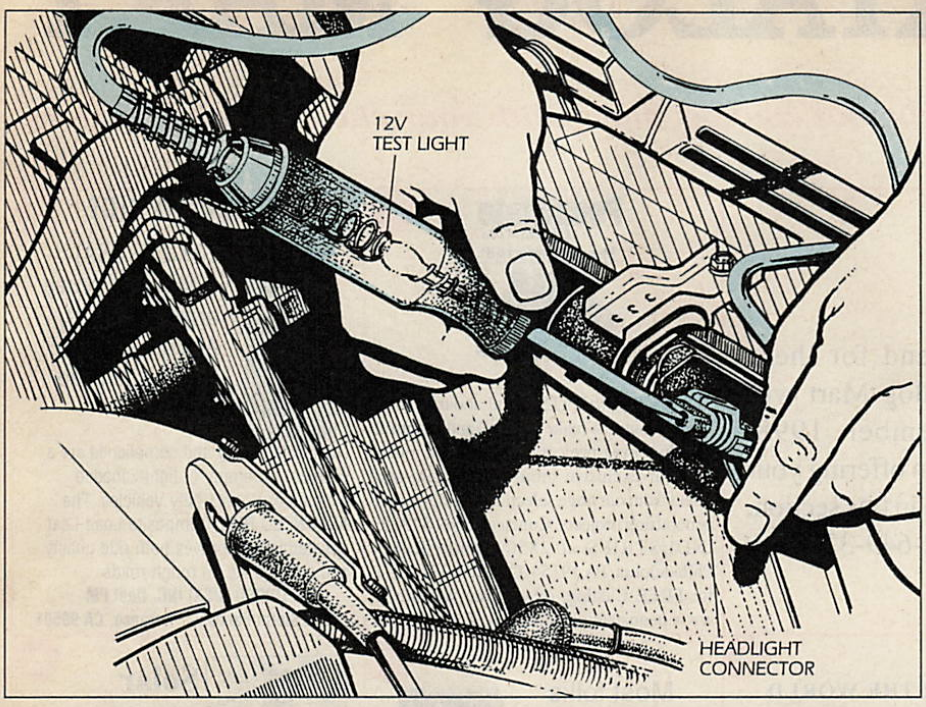
Replaceable bulbs

Many late-model cars have a replaceable bulb plugged into the back of the lens assembly instead of the sealed beam (European cars have always used this type). Typically, the bulb has a wiring connector held by a plastic locktab, and a plastic lockring to hold the bulb.

Pry up the tab (with a thin screwdriver, if necessary) and hold it up as you pull the harness

(Please turn to page 117)

PM ILLUSTRATION BY WENDY PAGANO



PM ILLUSTRATION BY WENDY PAGANO

Use a simple 12v test light to confirm operating power and ground circuits before replacing an expensive bulb or sealed beam.

connector off the terminals on the bulb. You can probe the harness connector the same way as on the sealed-beam design to make sure the bulb is at fault. An alternative: If the bulb is easy to remove, take it out for inspection. Turn the plastic lockring, which may come out or stay loosely in place. Then grasp the bulb by its connector and gently rock it out (it seals with an O-ring to keep out dirt and moisture). If the bulb filament is burned out, that tells you it's most likely the problem. Warning: Replaceable bulbs are usually quartz-halogen—and touching the bulb with your fingers will leave fingerprints that will crack the quartz glass within a few hours. The new bulb will be wrapped in cardboard or foam, so don't remove the wrapping until last and avoid touching the bulb. Too late? Clean the bulb with alcohol and a clean cloth.

When you install the new bulb, work it in very carefully, then push smoothly to seat it in the lens housing. This ensures that the O-ring seals properly instead of being twisted or dislodged.

A bulb or sealed-beam harness connector may have a ribbed-rubber moisture seal if the location poses a problem with road splash. When you see this setup, make sure it enters the bulb connector uniformly and seats evenly.

Replace it with the same type of bulb or sealed beam as the one that came out. You may see high-performance versions of the type you removed on the auto parts store shelf. If you want to install one of these instead, replace the one on the other side too, for even lighting. **PM**

MEN WHO FLY JETS *(Continued from page 61)*

part of his air show business, where a 12-minute routine consumes 250 gallons of fuel. At cruise, the red-star rocket tempers its appetite to about 350 gallons per hour.

One of the hottest warbirds in private hands is the MiG-21, code-named "Fishbed" and "Mongol" by NATO. The fourth in a series of jet fighters developed by Mikoyan—then directed by Colonel-General Artem I. Mikoyan and his top mathematician, Mikhail I. Gurevich (MiG)—this fast, highly maneuverable fighter is arguably one of the most significant ever built. The MiG-21 has been produced longer, and in greater numbers—over 11,000—than any other supersonic fighter, and it has taken part in the most combat missions since 1965.

Cranking out 9500 pounds of dry thrust, 13,100 pounds with afterburner, from its single Tumansky-designed turbojet, the 21 will hit 1320 mph, or Mach 2 at altitude. Fuel burn is about twice that of the MiG-17.

The example shown here was said to have been acquired from China—where it was manufactured—by a broker. But the real story is that it is Hungarian. Since it was illegal at the time to import the plane from Hungary, the MiG was shipped to China, slapped with all kinds of Chinese stickers, and then shipped to the United States under the guise of the plane's being a Shenyang F-7—the Chinese version of the MiG-21.

The MiG was acquired by Jim Robinson, a collector who established the Combat Jets Flying Museum of Houston. Robinson subsequently donated his collection, including the MiG-21, to the Experimental Aircraft Association. The MiG is flown infrequently, due to high operating costs, by two pilots, one of whom is Hoot Gibson.

Gibson's flying credentials are impressive, to say the least. He is a former Navy fighter pilot and an astronaut, having flown five space shuttle missions, four of those as pilot-in-command. His final flight involved docking with the Russian MIR space station in 1995. Gibson was Chief Astronaut from '92 to '94 and retired from NASA as deputy director of crew operations. Guess they'll let him try the MiG when he wants to.

Since Gibson has firsthand experience flying both the F-4 Phantom and MiG-21, planes that squared off against each other in the skies over Vietnam, we couldn't resist asking him which he would choose in a dogfight. Gibson didn't hesitate in answering. In daytime visual flight conditions, where the Phantom's radar wouldn't be a factor, he'd prefer to do battle in the MiG. Both warbirds have about the same power, maybe a hair less on the MiG, so the Russian jet could use its vertical performance as well as the Phantom could.

Being more maneuverable than the U.S. fighter, the MiG-21 will fly circles around the F-4. On the other hand, the faster F-4 is able to engage and disengage a dogfight at will.

Gibson says that flying the MiG-21 dispelled the belief widely held by U.S. pilots that the plane had poor forward visibility because of a 4-½-in.-thick bulletproof windscreen, and that the enemy pilots couldn't see us very well out the front. Rubbish. The screen produces no distortion, and once the canopy comes down, you totally forget it's there. You bet they could see us.

With proper background and training, almost anyone can join the exclusive jet fighter club. The price of admission is reasonable enough, compared with other flying options, but an active oil well in your backyard sure would come in handy at fill-up time. **PM**

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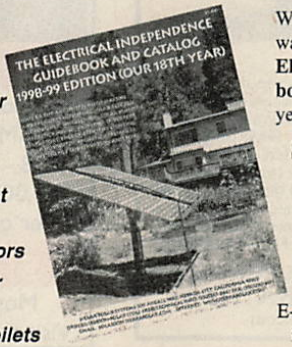

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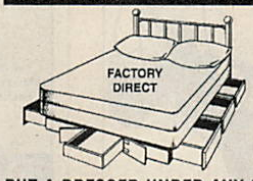

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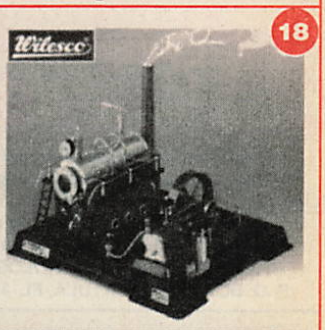

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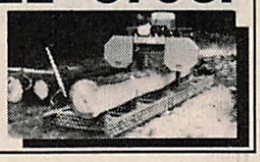

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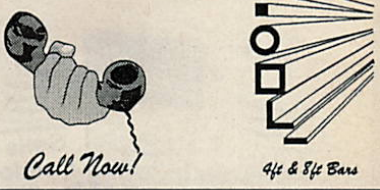

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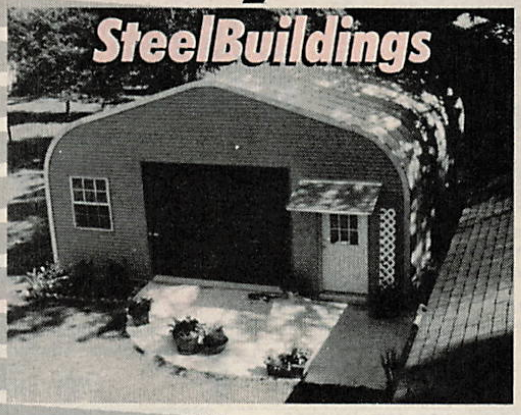

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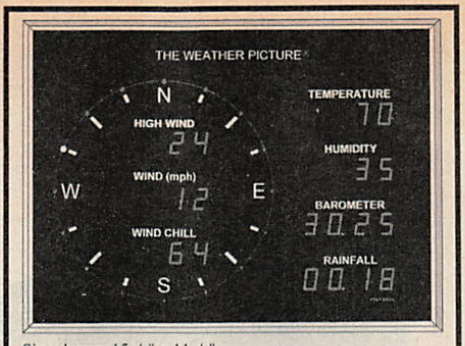

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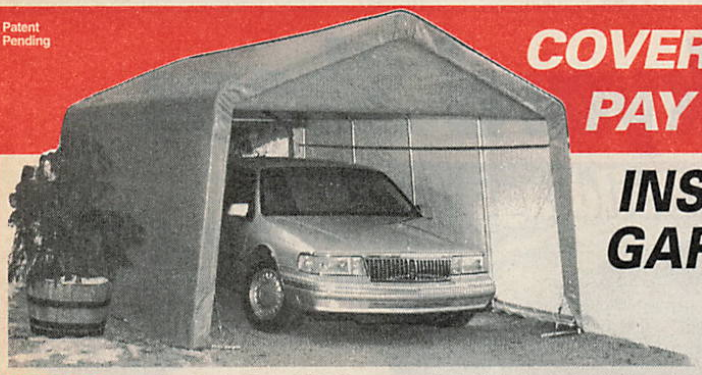

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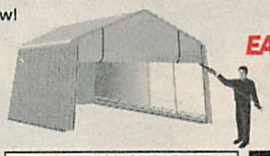

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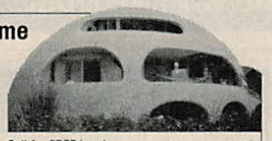

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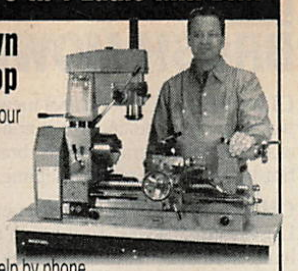

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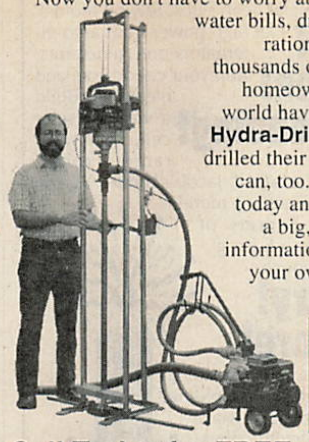

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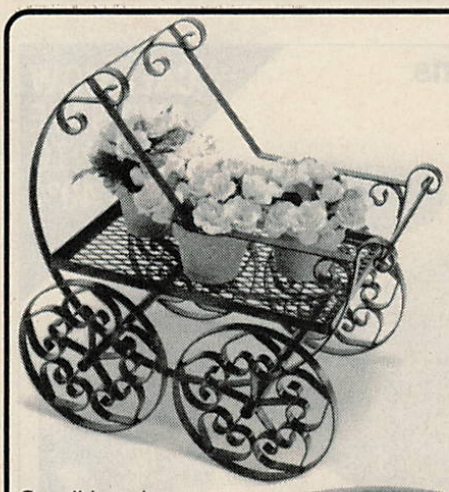

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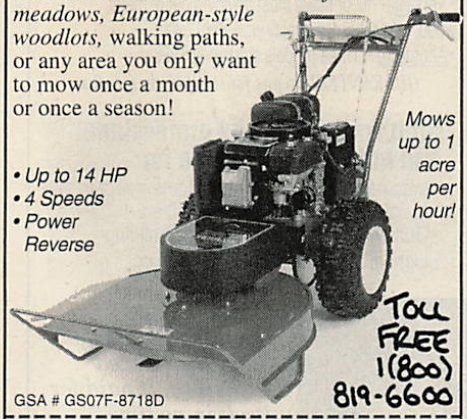

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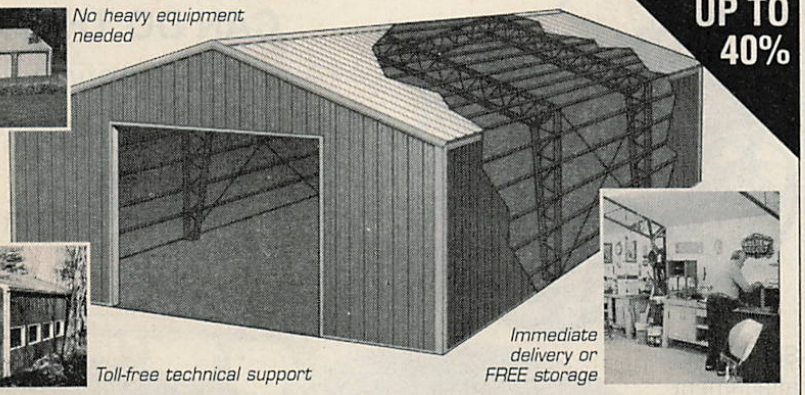

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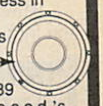

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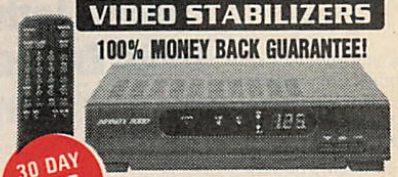

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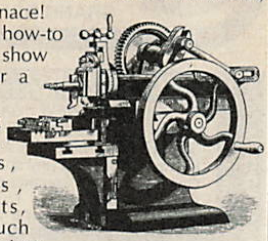

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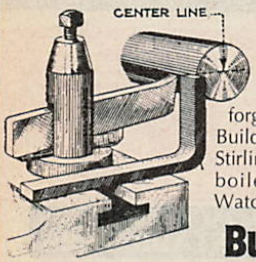

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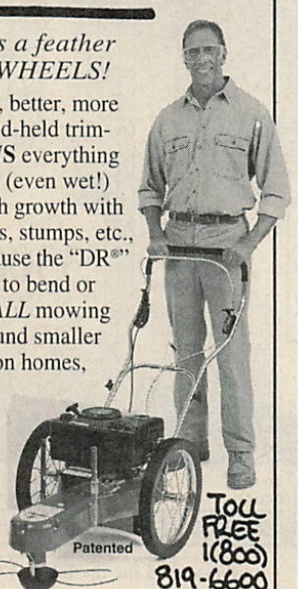

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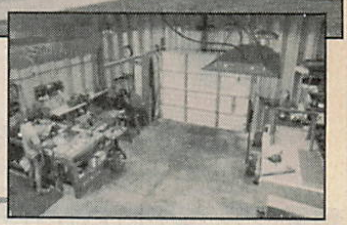

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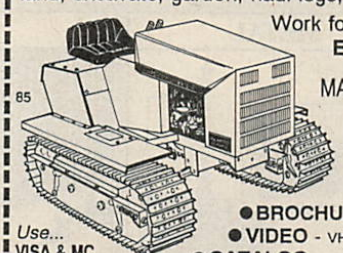

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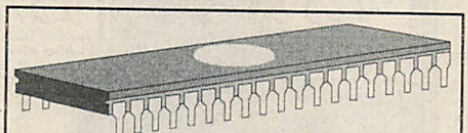

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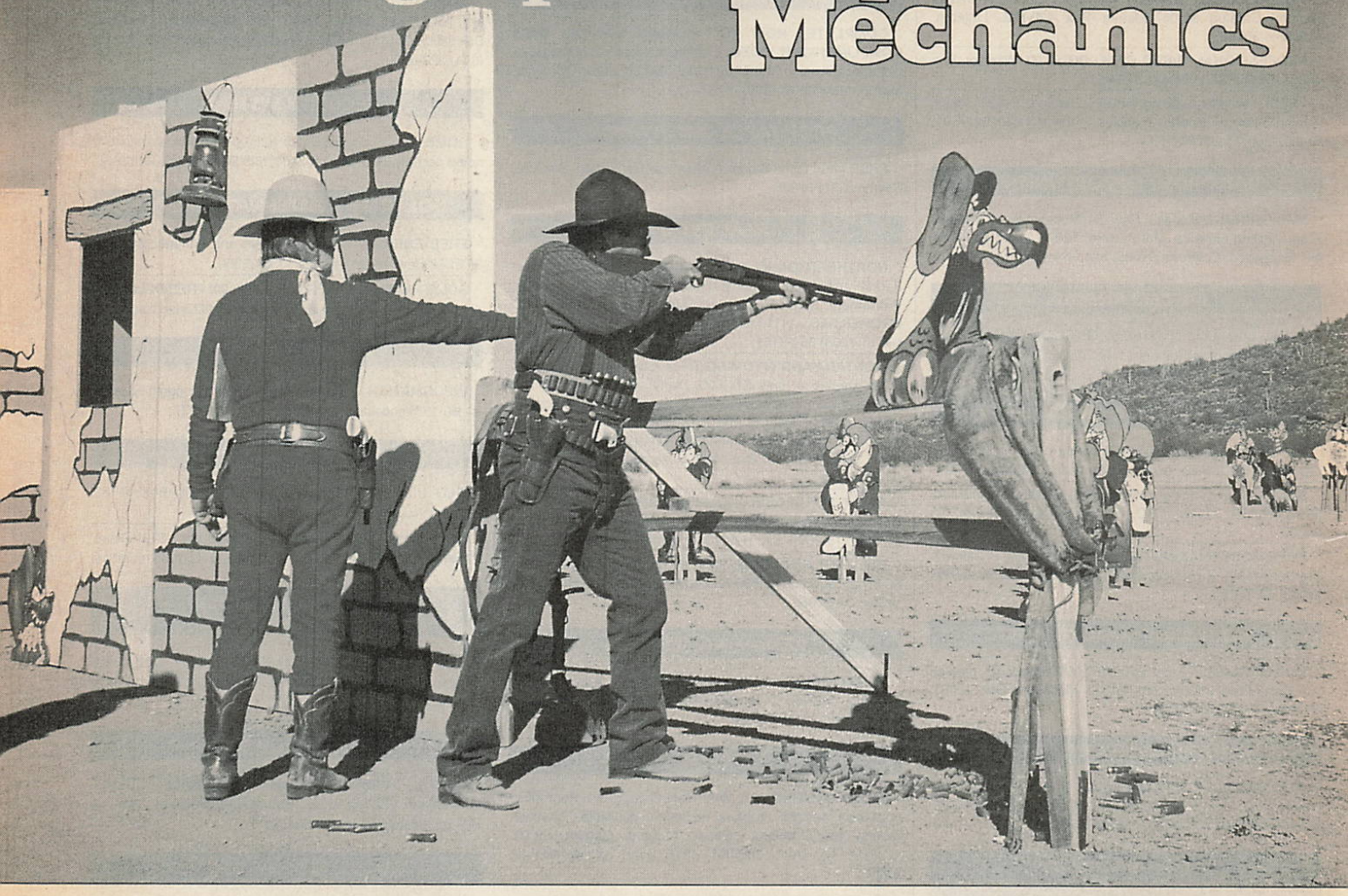

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